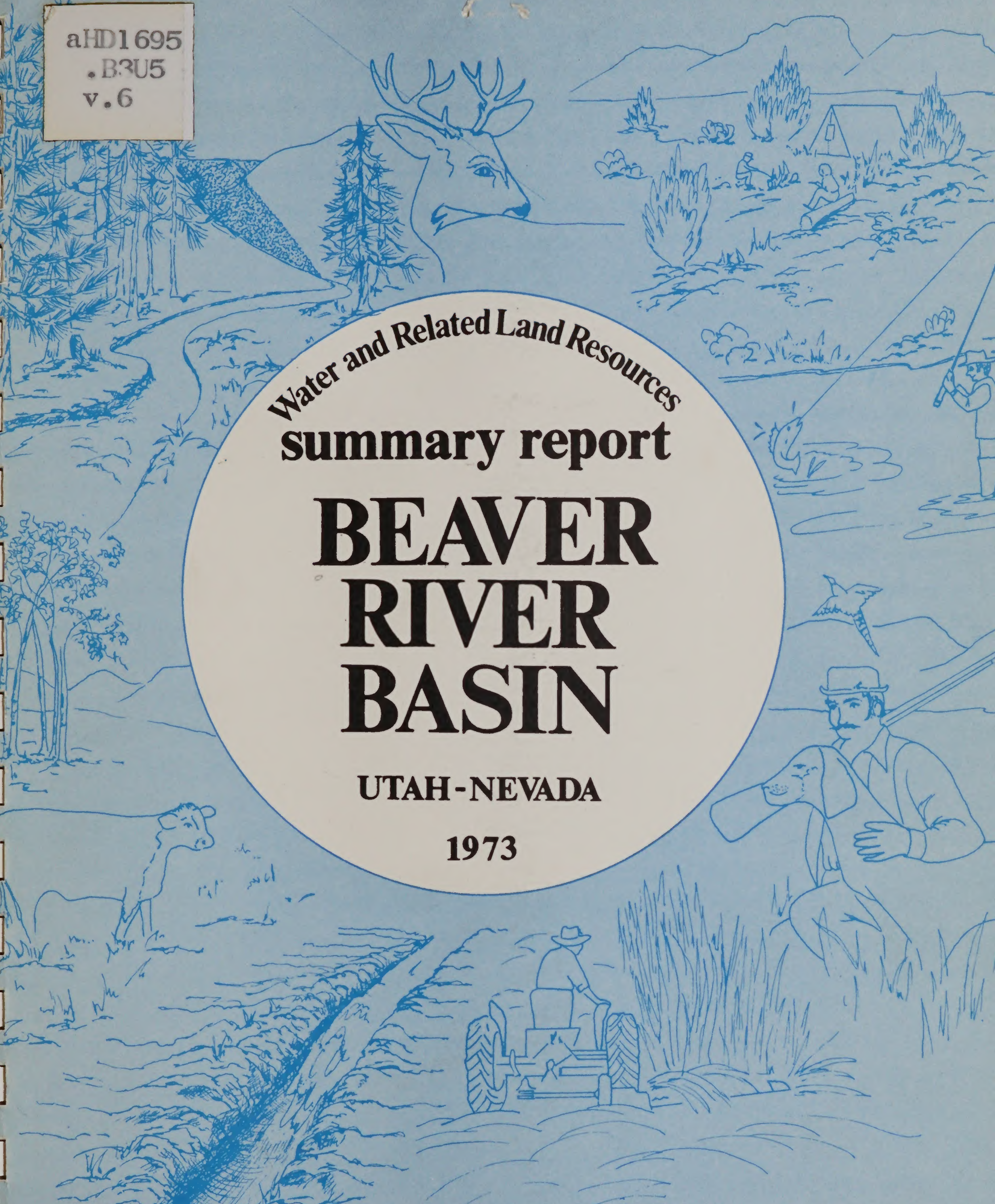
Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

Reserve
aHD1695
.B3U5
v.6



Water and Related Land Resources

summary report

BEAVER RIVER BASIN

UTAH-NEVADA

1973

prepared by
UNITED STATES DEPARTMENT OF AGRICULTURE
Economic Research Service · Forest Service · Soil Conservation Service
In cooperation with
Department of Natural Resources, State of Utah

AD-33 Bookplate
(1-63)

NATIONAL
AGRICULTURAL
LIBRARY

V. 6

SUMMARY REPORT

WATER AND RELATED LAND RESOURCES

BEAVER RIVER BASIN

UTAH AND NEVADA

Prepared by
United States Department of Agriculture
Economic Research Service-Forest Service-Soil Conservation Service
in cooperation with
Utah State Department of Natural Resources
and
United States Department of Interior
Bureau of Land Management

June 1973

U. S. DEPT. OF AGRICULTUR
NATIONAL AGRICULTURAL LIBR
MAR - 8 1977
CATALOGING

The following publications have been prepared under the Beaver River Basin study:

Summary Report

Appendix I [a] Natural Resource Inventory
[b] Soils Supplement

Appendix II [a] Present and Projected Resource Use and Management
[b] Water Related Land Use Supplement
[c] Water Budget Analysis Supplement

Appendix III Resource Related Problems

Appendix IV Economic Base and Needs (Projections)

Appendix V Potential Development Opportunities
Irrigation Systems Supplement

451578

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

TABLES

TABLES (continued)

FIGURES

MAPS

PHOTOS

All photos are courtesy of the Forest Service or Soil Conservation Service unless otherwise noted.

CHAPTER I

SUMMARY

OBJECTIVE AND SCOPE

This report presents information on water and related land resources in the Beaver River Basin portion of the Sevier Lake Basin, Utah and Nevada. It contains 5.2 million acres and is 145 miles long, north to south, and 116 miles wide. Most of the area is within the Basin and Range Physiographic Province although the eastern edge is within the High Plateaus Province.

This report identifies problems and needs concerning the conservation and use of water and land resources and emphasizes development opportunities through the initiative of local sponsors. It also provides information to plan programs of the U.S. Department of Agriculture, other federal agencies, and the state of Utah, and provides a basis for effective coordination between these agencies.

Although land resources were studied, they were examined primarily as they relate to water. This study focuses on water resources and analyzes their importance to economic development. Available data supplemented by field surveys were used and findings suggest many opportunities for individual and group action could contribute to overall development of water and related land resources. However, additional investigations of some projects will be required prior to detailed planning and implementation.

A water budget program was developed to evaluate water resource-inflow-use-outflow relationships. A second evaluation determined inflow-use-outflow relationship of irrigation water based upon a crop priority system. The two analyses resulted in different figures for consumptive use deficits and other hydrologic data. The water budget program resulted in an average annual consumptive use deficit of 62,470 acre-feet and the irrigation program 77,150 acre-feet. The irrigation program deficits were the values used in the evaluation of development opportunities and their impacts.

Social, legal, and economic considerations may impede some developments, strengthen interest in others, or identify need for additional study. These considerations were considered but did not limit evaluation of alternative developments.

This report summarizes the information and data presented in the appendices and their supplements. For additional detail regarding data presented and procedures used, refer to these reports.

PROBLEMS AND NEEDS

New development and acceleration of existing programs is needed to make more efficient use of resources. Improved water and related resource management, floodwater and sediment control, and soil stabilization are all needed to solve problems. This will require additional and accelerated financial and technical help.

Heavy to excessive erosion is found on 7 percent (367,000 acres) of the area. Average annual sediment yield is 0.53 acre-feet per square mile and about 0.4 acre-feet per square mile on an additional 1.4 million acres. Basin-wide sediment yield averages less than 0.3 acre feet per square mile. Flood damages are estimated to exceed $387,000 annually. Nearly 5,000 acres of irrigated cropland needs drainage. There are 420 miles of irrigation canals of which 68 percent are in poor condition and have water losses in excess of 6 percent per mile.

In the past, ground water reservoirs have been depleted faster than they have been recharged. Ground water levels declined an average of 10 to 50 feet during the 1956-1965 study period. If these levels continue to decline, pumping costs will increase and eventually, this water supply will be depleted.

Low per capita income and an increasing average age of the work force indicate a declining economy. Stabilization and enhancement of the economy is a primary need. Economic expansion should be encouraged to provide employment.

FINDINGS AND CONCLUSIONS

Identification of potential opportunities and solutions to problems in this report does not imply they are the only developments or that they will be supported by the private sector or by public, state, and federal agencies for development. Present legal constraints prevent implementation of development on National Forests within inventoried roadless areas until studies of wilderness and preservation alternatives are completed. Their identification is based upon reconnaissance level investigations and more detailed analysis as to their economic and physical feasibility as well as environmental impact will be needed prior to implementation.

DEVELOPMENT POTENTIAL

Development potentials include 77,300 acres of watershed stabilization on public lands and 205,200 acres of range forage improvement on national forests, private, and state lands. Watershed improvement will help alleviate erosion, flood, and sedimentation problems and maintain productivity. Recreation activity is expected to increase four times by the year 2020. There are abundant opportunities for many recreation activities to meet this demand; however, there is a need for related services. There is potential to develop over 60 outdoor recreation facilities. There are development potentials on public land to improve over 42,500 acres of big game habitat and 60 miles of stream fish habitat.

On-farm land leveling or sprinkler irrigation on 53,800 acres of irrigated cropland; installation of 770 miles of ditch lining or pipelines, and associated irrigation structures; construction of 290 miles of off-farm canal lining would relieve water shortage problems. On-farm and off-farm irrigation improvements could increase the average overall irrigation efficiency by 27 percent. This could decrease the average annual root-zone consumptive use deficit based on the irrigation program by nearly 60 percent.

The total volume of storage in ground-water reservoirs has not been identified. There is a potential to increase water use from this source and mine ground-water reservoirs on a one-time basis. The rate of mining would determine the period of time this resource would be available.

There are 13 surface reservoir sites that appear favorable for potential development. These could provide storage for floodwater and sediment, irrigation water, and recreation.

SOLUTIONS AND RECOMMENDATIONS

There are many opportunities to accelerate U.S. Department of Agriculture programs, other federal programs, State programs, and activities of private land owners to alleviate resource problems and improve the economic well-being of the area. Most of the development opportunities will be relatively small in magnitude such that they can be implemented through local action with technical and financial assistance from federal and State programs.

Findings indicate implementation of four watershed projects under PL-566 will be feasible within the next 10 to 15-year period at a total installation cost of $6.7 million. Three additional projects will be feasible for construction beyond this period.

Other development opportunities within the next 10 to 15-year period include the following:

1. Reservoir development at 13 sites to store 25,250 acre-feet of water for multi-purpose uses.

2. On-farm land treatment and off-farm conveyance system improvements to increase the overall irrigation efficiency by 6 percent.

3. Watershed stabilization of critical and disturbed areas totaling 14,350 acres to annually reduce erosion by 36 acre-feet, sedimentation by 14 acre-feet, and flood damages by $5,700.

4. Forage improvement on nearly 47,000 acres to provide over 13,000 AUM's annually. (Public domain lands are not included.)

5. Installation of 16 recreation facilities of various types to provide an additional 117,000 visitor-days capacity annually.

The study points out several areas where efforts should be concentrated in addition to the opportunities described above. It is recommended that action be initiated on the following:

1. Initiate a detailed study of the ground water-surface water relationships with specific emphasis on the effects of increased irrigation efficiencies, surface water storage, and changes in water use patterns on economic relationships, conjunctive use and management, water quality, and quality of life.

2. Land use planning, especially in development pressure areas, to regulate growth and protect the resource base recognizing private land owner rights and public values. Recreational planning, including residential developments, are especially critical.

3. Acceleration of programs to reduce erosion, sedimentation and flooding to improve the quality of the water supply.

4. Provide economic stimulus through more intensive use and management of the resources. This will also require financial aid from other than local sources.

IMPACTS

The impacts of proposed programs and projects would be felt in all activities throughout the Basin. Grazing management and allotments will be altered. Vegetative manipulation and cropping

pattern changes will increase the water available for irrigation or other uses and permit exchange and transfer of water rights. Although more efficient use of water will likely reduce downstream-flow patterns, these effects could be offset by water-saving projects. Land resources will be conserved through floodwater and sediment control and soil stabilization.

The development of accelerated on-farm improvement practices on presently irrigated land would result in annual agricultural benefits of about $316,700. With the development of accelerated off-farm conveyance system improvements there will be over $169,400 in annual agricultural benefits. This would increase the net income to farmers by over $215,000 annually.

Development programs on national forest and other forested lands will reduce sediment, floodflows and provide increased grazing capacity valued at nearly $75,000 annually. In addition, recreation developments on public lands will accommodate 117,000 visitor-days annually.

CHAPTER II

INTRODUCTION

The Governor of Utah requested the U.S. Department of Agriculture to expand the Sevier River Basin Study to include the remaining part of the Sevier Lake Drainage. This additional area, or the Beaver River Basin, which together with the original Sevier River Basin Study, make up the Sevier Lake Basin. The Sevier Lake Basin is a subregion of the Great Basin Region Comprehensive Framework Study (map following page 8). The Sevier Lake drainage comprises 10.44 million acres of land and water area; 5.24 million acres in the Beaver River and 5.20 million acres in the Sevier River study area. Approximately 70,000 acres of Beaver River Basin are in Nevada. Tintic Watershed, containing over 162,000 acres, is included in the study, but separated from the contiguous Beaver River Basin.

DESCRIPTION OF STUDY AREA

Beaver River Basin extends from the Pine Valley Mountains on the south to Sevier Lake on the north. The east border lies on the High Plateaus, with the bulk of the area extending westward to the Wah Wah Mountains and House Range in the Basin and Range Province. It is about 145 miles long and 116 miles wide. Counties partially or entirely within the area are Beaver, Iron, Juab, Millard, Washington, and minor areas of Sevier and Garfield. The small area in Nevada is in Lincoln County. Beaver, Iron and Millard counties comprise the major land area.

All perennial streams and most intermittent and ephemeral streams originate in the high mountains along the east and south edges of the Basin. The undiverted portion of these streams seldom leave these enclosed basins; they either evaporate or become part of the ground-water reservoir as they infiltrate the valley floors. Surface flows of Beaver River seldom pass Milford. This drainage joins the Sevier River shortly before entering the Sevier Lake playa.

Elevations range from 4,519 feet above sea level at Sevier Lake playa to 12,173 feet at Delano Peak in the Tushar Mountains. Sharp contrasts in topography, precipitation, soils, and vegetation

are evident as mountains rise abruptly from the valley floors resulting in a wide range of environments and biotic communities. Precipitation ranges from 6 inches to more than 40 inches annually. Frost free periods in the valleys range from 107 days at Beaver to 159 at Modena.

Major highway transportation routes are Interstate 15 and U.S. 91 which connect the principal towns of Fillmore, Beaver, Parowan, and Cedar City. The Union Pacific railroad follows a more sparsely populated desert route to the west with Milford the only major city along the route.

The 1970 population was 18,450; the largest community, Cedar City, had a population of 8,950. The economy is primarily agricultural, but tourism, mining, and manufacturing are also significant. Most agricultural enterprises are related to livestock production. People do not live on farms, but reside in communities. These small communities are relatively free of environmental and social problems and living is more relaxed. Social life mostly centers around school and church activities.

NEED FOR THE STUDY

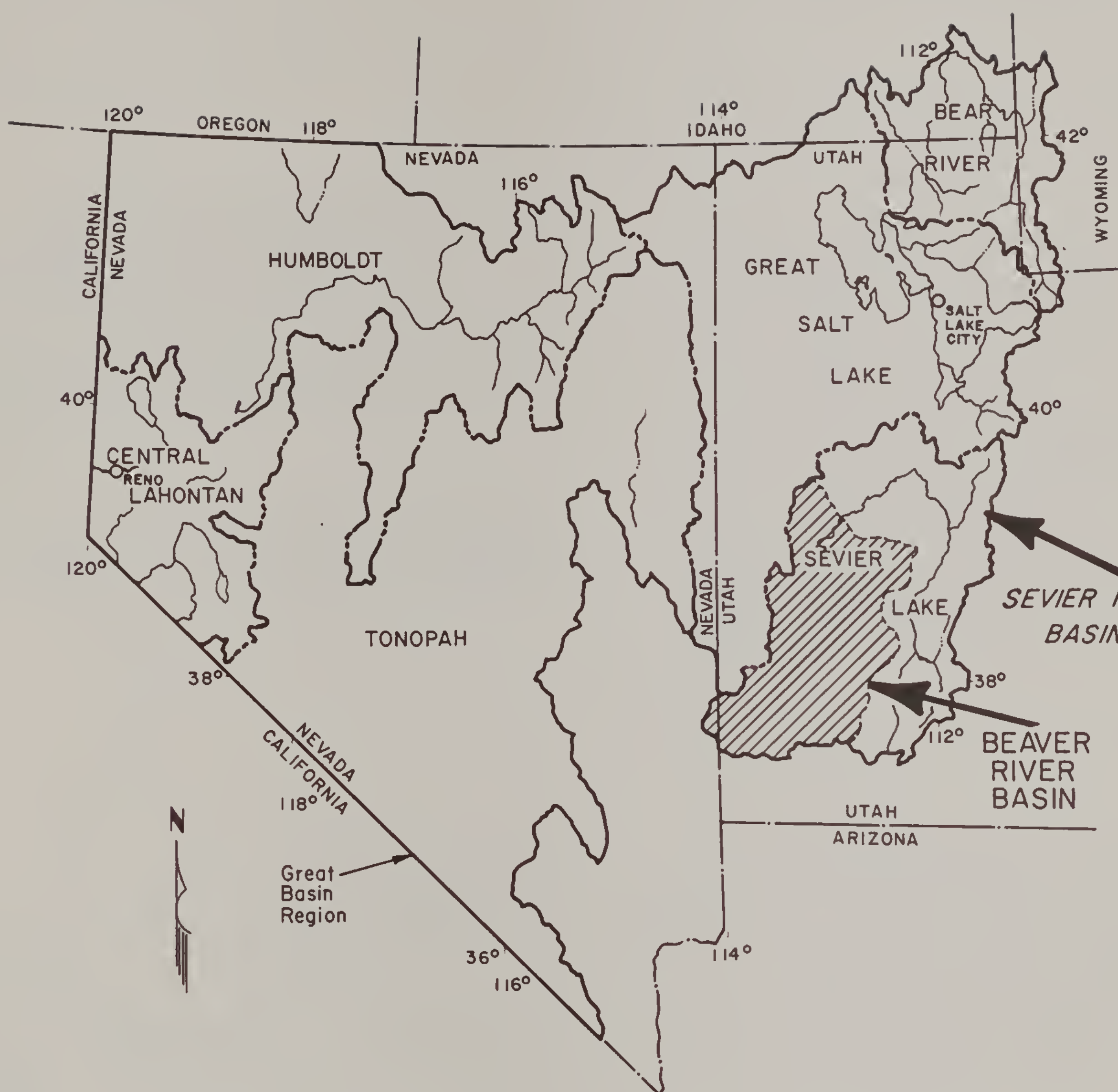
Economic and resource problems led to the need for a study coordinated among federal agencies and focusing on water and related land resource development opportunities.

The Governor stated in the study request, that additional information was needed to facilitate preparation of a state water plan. This study will help fulfill this need. Information provided will facilitate better understanding of resources and their inter-relationships, and describes potential resource use opportunities.

AUTHORITY AND COOPERATORS

Participation in this study by the U.S. Department of Agriculture is authorized under provisions of Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666 as amended).

The Governor assigned the Division of Water Resources to carry out the State's responsibilities, both for assisting in the study and for coordination between other federal and State agencies. Work was coordinated by a USDA Field Advisory Committee representing



ORIENTATION MAP
BEAVER RIVER BASIN
UTAH-NEVADA
JUNE 1973

0 25 50 75 100 125 150
APPROXIMATE SCALE IN MILES

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

Washington, D. C. 20250

SUBJECT: River Basins - Beaver River Basin, Utah and Nevada DATE: OCT 7 1974

TO: Miss Leila P. Moran
Librarian, NAL

77827

Attached for your information and file is a copy of the completed USDA Report entitled "Water and Related Land Resources, Beaver River Basin, Utah and Nevada." This report contains a Summary Report and five appendices, with the exception of Appendix IV, Economic Base and Needs. We will forward Appendix IV when it becomes available. This report presents information on water and related land resources in the Beaver River Basin portion of the Sevier Lake Basin.

This report is being furnished in accordance with your request to the River Basins Division, Soil Conservation Service. If you need additional copies or any information pertaining to this report, please let us know.

Robert E. Kohnke
Director
River Basins Division

Attachment

Received

Washington, D. C. 20250

River Basins - Beaver River Basin, Utah and Nevada OCT 7 1974

Miss Leila P. Moran
Librarian, NAL

Attached for your information and file is a copy of the completed USDA Report entitled "Water and Related Land Resources, Beaver River Basin, Utah and Nevada." This report contains a Summary Report and five appendices, with the exception of Appendix IV, Economic Base and Needs. We will forward Appendix IV when it becomes available. This report presents information on water and related land resources in the Beaver River Basin portion of the Sevier Lake Basin.

This report is being furnished in accordance with your request to the River Basins Division, Soil Conservation Service. If you need additional copies or any information pertaining to this report, please let us know.

Robert E. Kohnke

Robert E. Kohnke
Director
River Basins Division

Attachment

the Soil Conservation Service, Forest Service, and Economic Research Service. The study was accomplished by a USDA study team in cooperation with Federal, State, and local organizations which contributed by providing counsel, contributing information, and participating in public meetings. Their cooperation and help is gratefully acknowledged.

OBJECTIVES OF THE STUDY

The objectives were to inventory the water and related land resources, to define resource related problems, to evaluate needs, and to determine opportunities for resource development. Problems were identified by describing their causes, by analyzing their extent and frequency, and by estimating their economic and social consequences. Resource needs were identified regardless of competing or conflicting uses. Both present resource conditions and projected demand were considered. Opportunities are defined as the capability to manage or develop resources to alleviate needs and problems. Programs of the U.S. Department of Agriculture and the State of Utah were emphasized in meeting objectives. Emphasis was also placed on PL-566 watershed investigations.

NATURE OF STUDY

The study consisted mostly of an accumulation and evaluation of previously recorded data, both published and unpublished, much of which was furnished by cooperating agencies. Other information was obtained through consultation with local, public, and private officials, and reconnaissance surveys. Limited studies were made to gather information not available from other sources. Unless otherwise indicated, data are presented for the 1956-65 base period.

The Basin was divided into 22 watersheds which were grouped into 5 hydrologic subbasins (map following page 10). Most data were collected and tabulated for each watershed and then assembled by subbasins for analysis. Data were published in the following appendices:

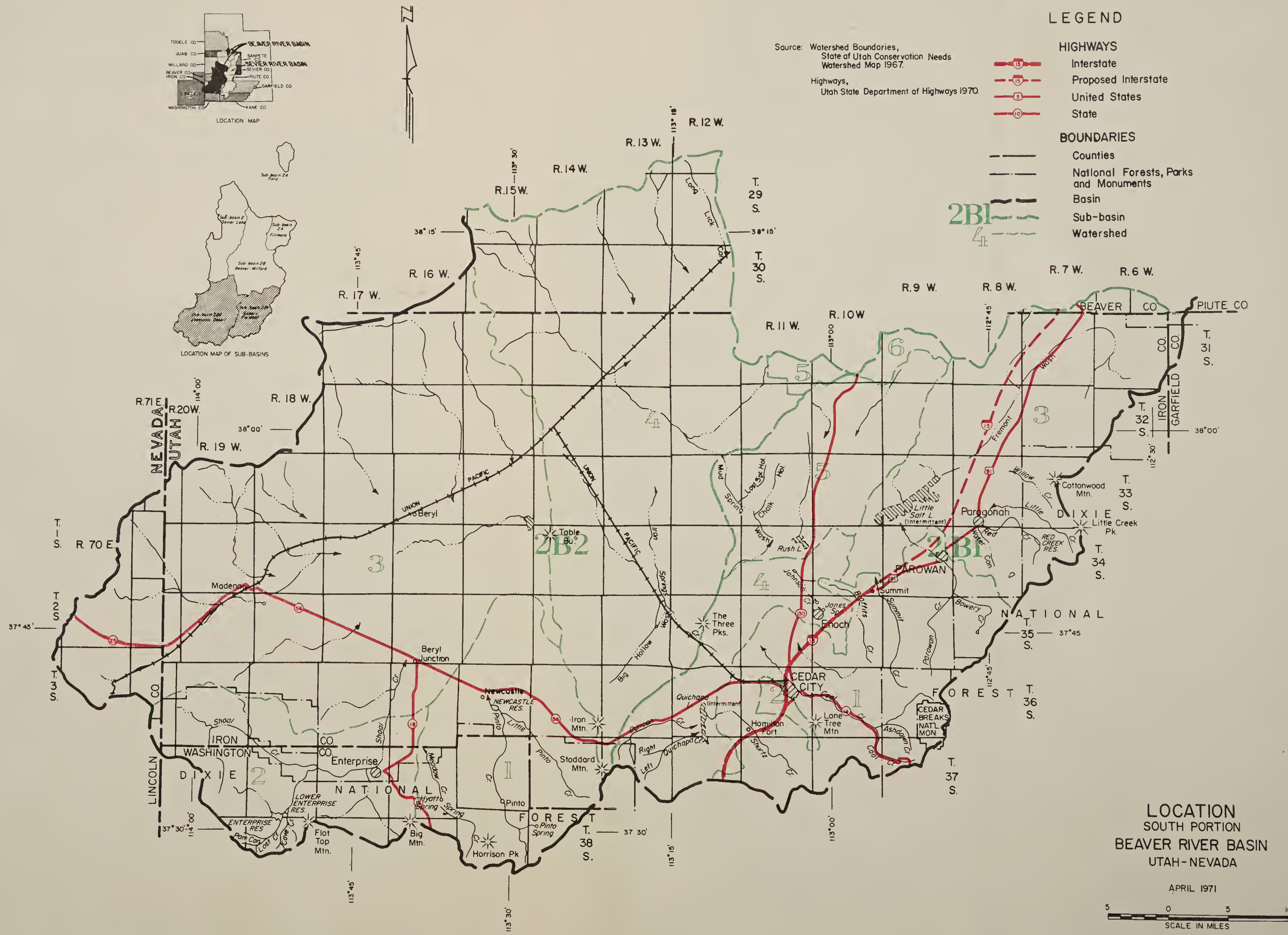
Appendix I - Natural Resource Inventory
Appendix II - Present and Projected Resource Use and Management
Appendix III - Resource Related Problems
Appendix IV - Economic Base and Needs (Projections)
Appendix V - Potential Development Opportunities

USE OF THE REPORT

This report can be used to assist in better management and utilization of water and related land resources. Information compiled and evaluations presented can be useful to the public and federal, state, and local agencies in comprehensive planning. It can provide data to Utah's "State Water Plan," to establish resource development priorities, to accelerate programs of the U.S. Department of Agriculture and the State of Utah, and can stimulate development of Soil Conservation District programs.

LOCATION
NORTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA

APRIL 1971



LOCATION
SOUTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA

APRIL 1971

CHAPTER III

NATURAL RESOURCES

This chapter describes natural resources, including geology and physiography, climate, land, water, and fish and wildlife. Additional information can be found in Appendix I, Natural Resources Inventory.

GEOLOGY AND PHYSIOGRAPHY

The area is essentially an enclosed basin. It is bounded on the east by a high rim which drops sharply to the valley floor exposing spectacular scenic views. Cedar Breaks National Monument, located along the southern portion of this rim, is a colorful amphitheater, eroded over eons of time into the Wasatch formation with its many brilliant hues of colored rock formations. From the top of this high vantage point, one can look westerly over a broad panorama of distant ranks of mountain ranges extending across vast vistas of pre-historic Lake Bonneville sediments. To the north, the mighty Tushar Mountains toss their snow-capped peaks into the clear blue sky. In direct contrast, the Sevier Lake playa to the northwest, swelters in the intense desert heat, dissipating any water it receives into the atmosphere.

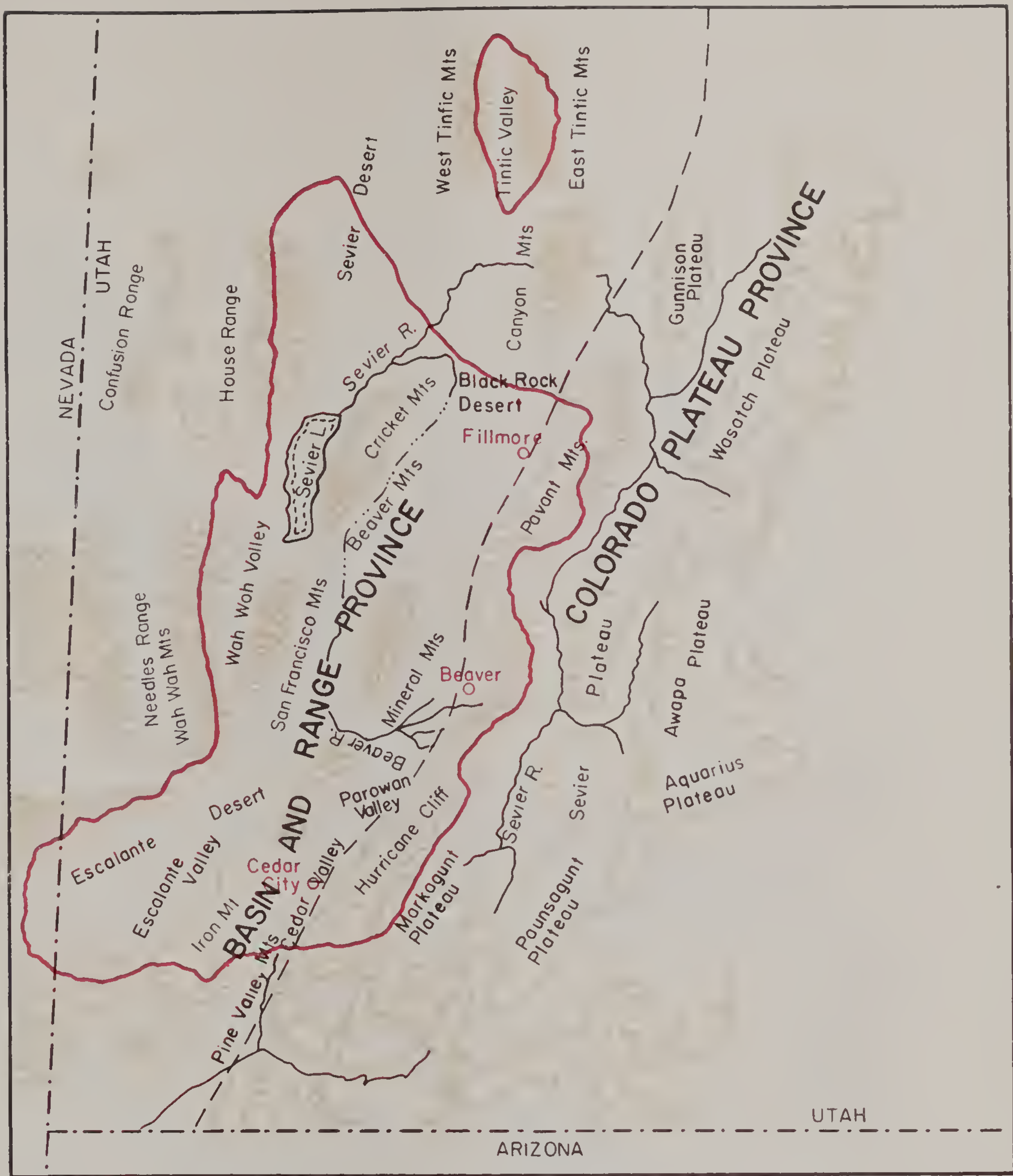
There is an expanse of contrasting environments, from the refreshing conifer-aspen forests and cool mountain streams to the scantily vegetated desert lands simmering in the summer heat; and from the man-made patterns of cultivated crops surrounding isolated communities to the awesome desert monotony tempting the adventurous traveler. This is a place for those seeking solitude and peace, the colorful and spectacular, clean air and blue skies; or for those curious of the ways of nature; or for those looking for geological or archeological secrets of the past. The outstanding physiographic features are shown on the map following page 12.

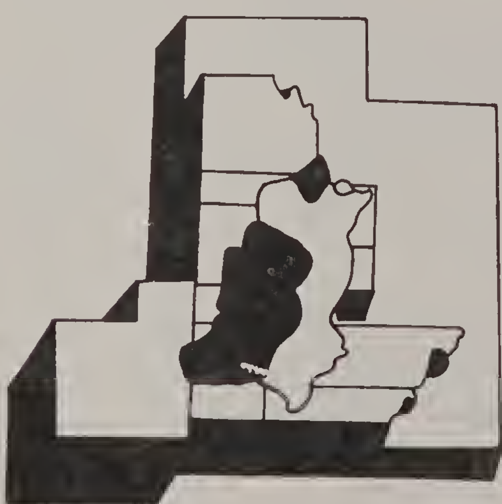
The Beaver River Basin lies in the Basin and Range Province of western Utah and the High Plateaus of central Utah. The area is characterized by a series of north-south mountain ranges, separated by arid basins or valleys floored by detritus from the eroding mountains. Approximately 70 percent of the Basin and Range Province is covered with unconsolidated sediments.

The mountains are geologically young, block-faulted, and tend to form parallel ridges, generally less than 9,000 feet in altitude.

They are composed mainly of limestones, sandstones, shales, dolomites, siltstones, and quartzites. Exceptions are the Tushar Mountains of volcanic origin, over 12,000 feet in elevation; the Mineral Mountains, a granitic plug; and the Pine Valley Mountains, a large intrusion chiefly composed of quartz monzonite. Generalized geology is shown on the maps following page 12.

Beaver Valley with the Mineral Mountain Range in the background.





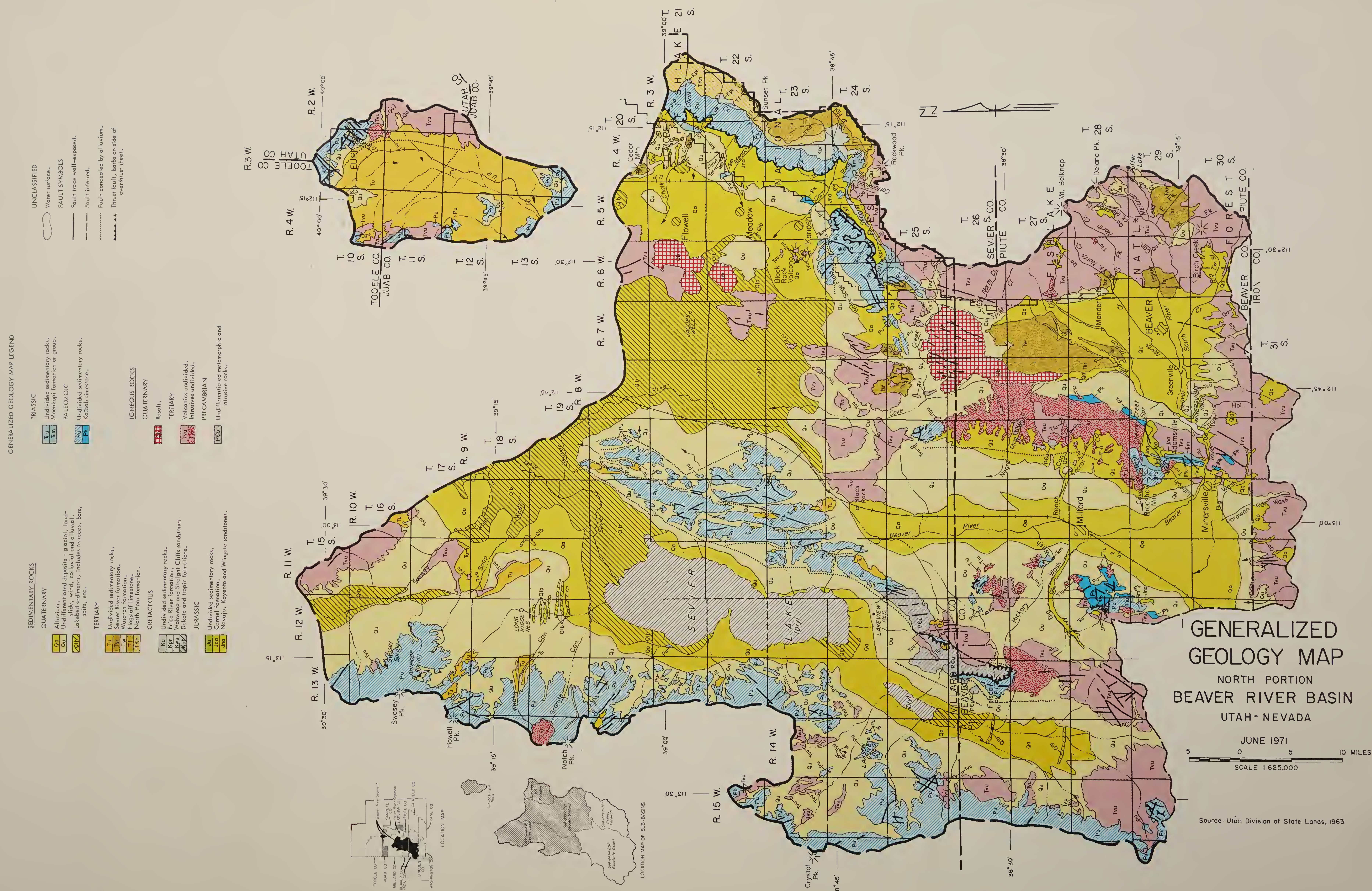
PHYSIOGRAPHIC FEATURES

BEAVER RIVER BASIN

UTAH – NEVADA

June 1972

Approximate Scale: 1 inch = 35 Miles



GENERALIZED GEOLOGY MAP

NORTH PORTION

BEAVER RIVER BASIN

UTAH-NEVADA

JUNE 1971

SCALE 1:625,000

5 0 5 10 MILES

M7-S-22076-N
North Portion

GENERALIZED GEOLOGY MAP LEGEND

SEDIMENTARY ROCKS

QUATERNARY

Qa	Alluvium.
Qu	Undifferentiated deposits - glacial, landslide, wind, colluvial and alluvial.
Qlb	Lakebed sediments, includes terraces, bars, spits, etc.

TERTIARY

Tu	Undivided sedimentary rocks.
Tsr	Sevier River formation.
Tw	Wasatch formation.
Tf	Flagstaff limestone.
TKn	North Horn formation.

CRETACEOUS

Ku	Undivided sedimentary rocks.
Kpr	Price River formation.
Kws	Wahweap and Straight Cliffs sandstones.
Kdt	Dakota and tropic formations.

JURASSIC

Ju	Undivided sedimentary rocks.
Jca	Carmel formation.
Jna	Navajo, Kayenta and Wingate sandstones.

TRIASSIC

Ŧu	Undivided sedimentary rocks.
Ŧm	Moenkopi formation or group.

PALEOZOIC

Pu	Undivided sedimentary rocks.
Pk	Kaibab limestone.

IGNEOUS ROCKS

QUATERNARY

Qb	Basalt.

TERTIARY

Tvu	Volcanics undivided.
Tiu	Intrusives undivided.

PRECAMBRIAN

P€u	Undifferentiated metamorphic and intrusive rocks.

UNCLASSIFIED

Water surface.

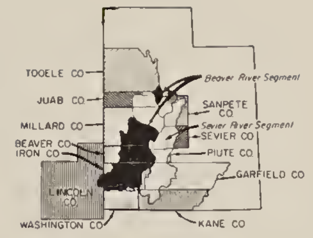
FAULT SYMBOLS

Fault trace well-exposed.

Fault inferred.

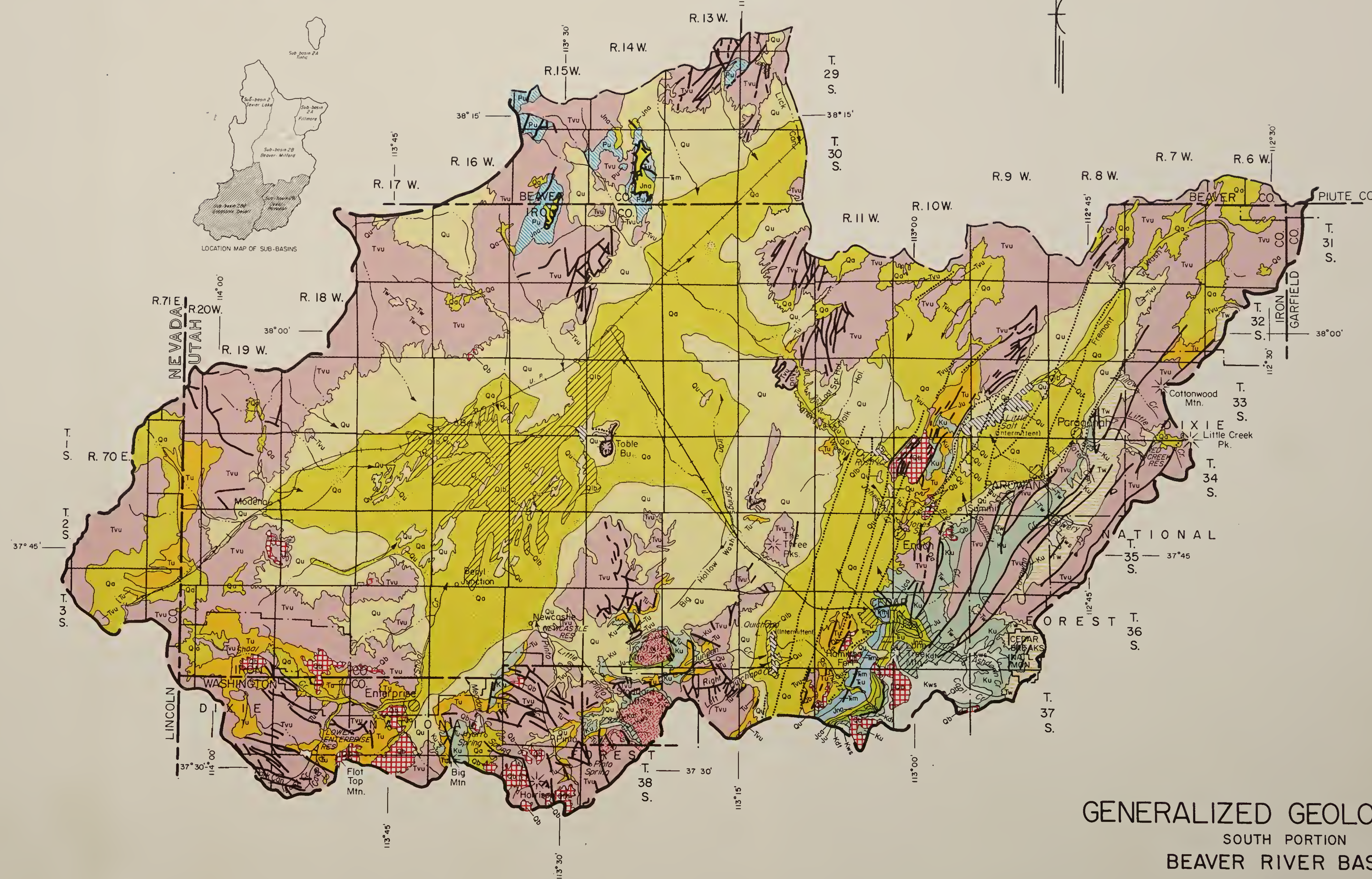
Fault concealed by alluvium.

Thrust fault, barbs on side of overthrust sheet.



LOCATION MAP

LOCATION MAP OF SUB-BASINS



GENERALIZED GEOLOGY MAP

SOUTH PORTION

BEAVER RIVER BASIN

UTAH - NEVADA

JUNE 1971

5 0 5 10 MILES

SCALE 1:625,000

Source: Utah Division of State Lands, 1963

M7-S-22076-N
South Portion

BASIN AND RANGE PROVINCE

Most of the north-south mountain ranges are complexly deformed Paleozoic rocks consisting basically of limestone. In some areas, rocks consist mostly of sandstone, siltstone, and shale derived from volcanic rocks. At about the time block faulting began, extensive volcanic eruptions occurred in many areas. Most of the volcanic activity trended southwesterly-northeasterly and these block faulted extrusives aided in the formation of some mountain ranges, with the down-faulted block forming the valley floor. The valley fill is composed of gravel, sand, silt, and clay beds ranging up to one mile thick. Recent activity along the faults has produced displacement in the gravel fans and valley fill along the bedrock, forming scarplets. This has created some of the present drainage anomalies.

Valleys range in altitude from 4,200 feet to 5,000 feet above sea level. Steep slopes bordering these valleys are cut by canyons with alluvial cones at their mouths and triangular facets on the spurs between. On the gentle slopes, broad alluvial fans merge into piedmont fans, extending, in many cases, nearly to the base of the next range. At the present time, the area is characterized by locally high erosion on the mountain ranges with deposition of alluvium on the valley floors during torrential summer rainstorms and high spring snowmelt runoff.

COLORADO PLATEAU PROVINCE

The eastern edge of the Basin has a northeasterly trend of fault blocks, many capped with volcanic flows, forming plateaus higher than 9,000 feet in elevation with a few at 11,000 feet. Tertiary sediments and gently dipping, basically nonmarine Mesozoic sediments, underlie these volcanics.

The area has a high structural rim formed by faulting. The western edge of the plateaus coincide with the relatively active seismic belt along the Hurricane fault, which relates to the continued deformation in that area. Extrusive igneous rocks are abundant. Erosion along the western face is high, especially during torrential summer rains. Alluvial fans are continually moving and flood plain deposition is active along the valley floors. Cedar and Parowan valleys are examples of such areas.

MINERAL RESOURCES

The value of copper, gold, lead, zonc and silver mined to date is approximately $322 million. High mining costs, low prices, and the problems of mining at great depths has caused a decline in production. Halloysite clay has been the most important

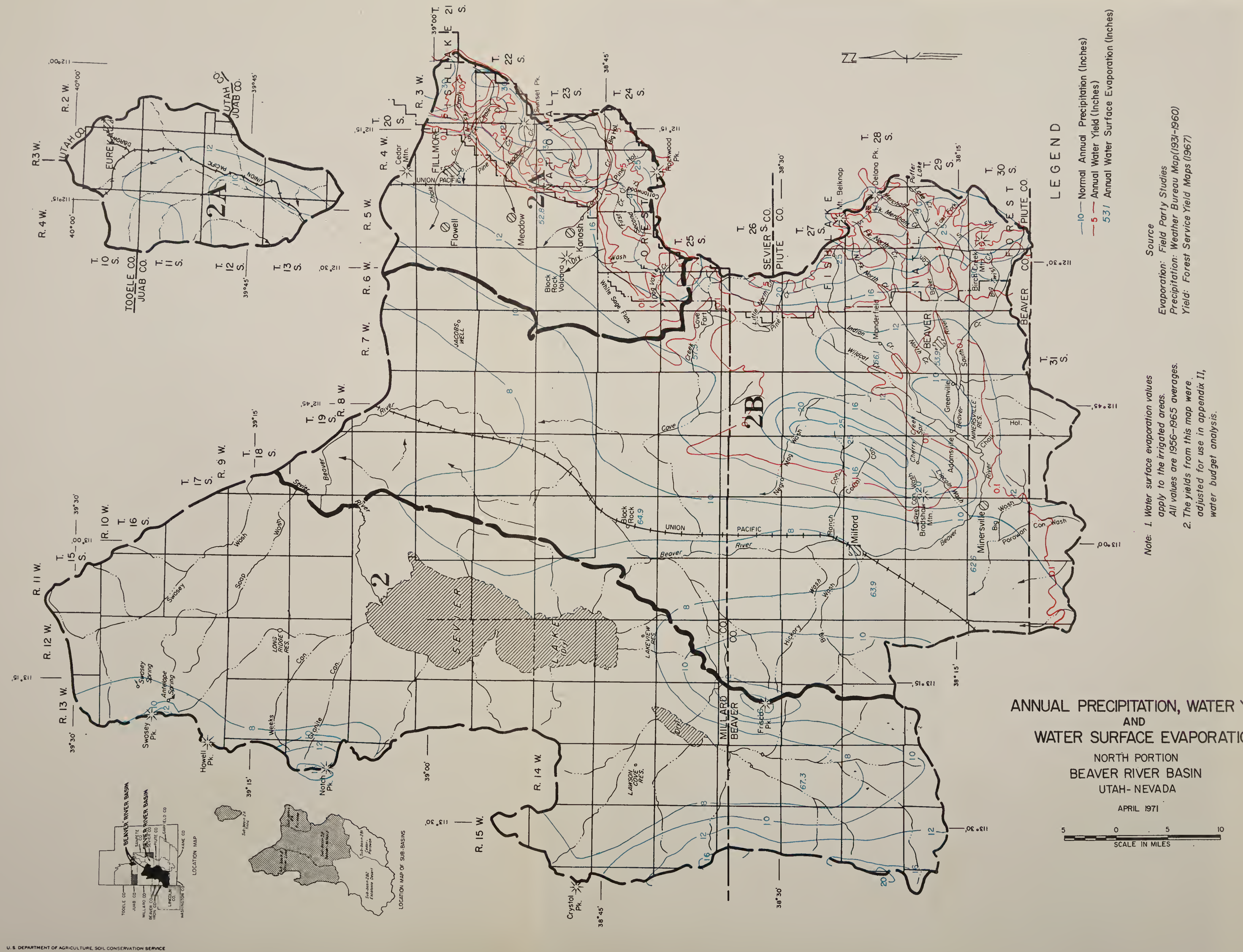
nonmetallic mineral. Annual production averages nearly 60,000 tons with a value of over one million dollars. Following are some of the important metallic and nonmetallic deposits and their location:

Metallic Minerals	Location
Iron	Iron Mountain
Tungsten	House Range
Uranium	Wah Wah Mountains
Copper, gold, silver, lead, and zinc	Tushar, Beaver, Mineral and San Francisco Mountains
Non-metallic Minerals	
Halloysite, kaolinite, montmorillonite, alunite, and fluorspar	Wah Wah Mountains
Cinder (Volcanic Scoria)	Black Rock Desert
Pumice and Perlite	Mineral Mountains
Gypsum	White Mountain
Sulphur	Tushar Mountains
Potassium	Sevier Lake
Coal	Markagunt Plateau

C L I M A T E

Precipitation is influenced by two major storm patterns. During winter and spring months, frontal storm systems from the Pacific Northwest predominate while during late summer and early fall summer thunderstorms move in from the south and southwest. Precipitation ranges from over 40 inches in the Tushar Mountains to about six inches in the Sevier Lake area (map following page 14). Climate in the valley areas is arid to semi-arid with an average precipitation of 10 inches. Basin precipitation for the 1956-1965 period averaged ten percent less than the long-term 1931-1960 normal. Moisture in the Escalante Desert was approximately 20 percent less for the 1956-1965 period than the thirty-year normal. Variability of precipitation is indicated by that at the Cedar City Powerhouse station where annual amounts ranged from 5 inches to 18 inches during the ten-year base period.

Temperatures fluctuate more than 100°F. almost every year, from a maximum of about 100°F. to a minimum of below zero. Daily temperatures may fluctuate as much as 40°F. Mean annual temperature in the valley areas varied from 47.4°F. in the Beaver area to 50.8°F. in the Sevier Desert. Mean monthly temperature for the Basin was 28°F. for January and approximately 74°F. during July or a range of 46°F. Average frost-free periods range from 159 days at Modena to 107 days in Beaver.



ANNUAL PRECIPITATION, WATER YIELD
AND
WATER SURFACE EVAPORATION

NORTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA

APRIL 1971

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

ANNUAL PRECIPITATION, WATER YIELD AND WATER SURFACE EVAPORATION

SOUTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA

APRIL 1971

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Annual water surface evaporation in the valley areas range from nearly 54 inches along the mountain fronts to 78 inches in the Escalante Valley and Sevier Desert. Possible sunshine varies from 82 percent during September to 47 percent during December. Prevailing winds are from the southwest at 7 to 12 miles per hour.

LAND RESOURCES

Land resources include soils, vegetation and minerals. Soils were mapped into 149 associations; the classification and characteristics are presented in the "Soils Supplement" Appendix I, Natural Resources Inventory. These 149 soil associations were combined into six zones. Vegetation was mapped and described by composition and area. Detailed data is not provided on mineral resources.

There are about 5.2 million acres of land ranging from desert to high mountains. The desert areas are used mainly for grazing livestock, although some areas are irrigated from streams or underground water sources. The mountain and high mountain areas are used primarily for grazing, recreation, and watershed.

SOILS

Soils are shown according to the zones in which they occur. These zones vary from temperate desert to cold, humid high mountains. About 52 percent of the soils are in the desert climatic zone, 16 percent are semidesert, 20 percent are upland, 6 percent are mountain, 5 percent are high mountain and about 1 percent wetlands (map following page 16).

The desert, semidesert and upland climatic zones have growing seasons suitable for crops such as alfalfa, small grain, and irrigated pasture. These soils comprise the following: 71 percent deep, non-saline, loamy or clayey and gravelly or nongravelly soils, 9 percent shallow soils, 8 percent saline-alkali soils, 7 percent rock outcrops, 3 percent playas, 1 percent very gravelly soils and 1 percent sandy soils. Many are on slopes too steep for cultivation.

The mountain climatic zone has a cool climate with short growing seasons (less than 100 days). The climate is suitable for hay and small grain crops. These soils are about 50 percent very gravelly, 25 percent shallow, and 25 percent deep and non-gravelly to gravelly. Many are on steep mountain slopes.

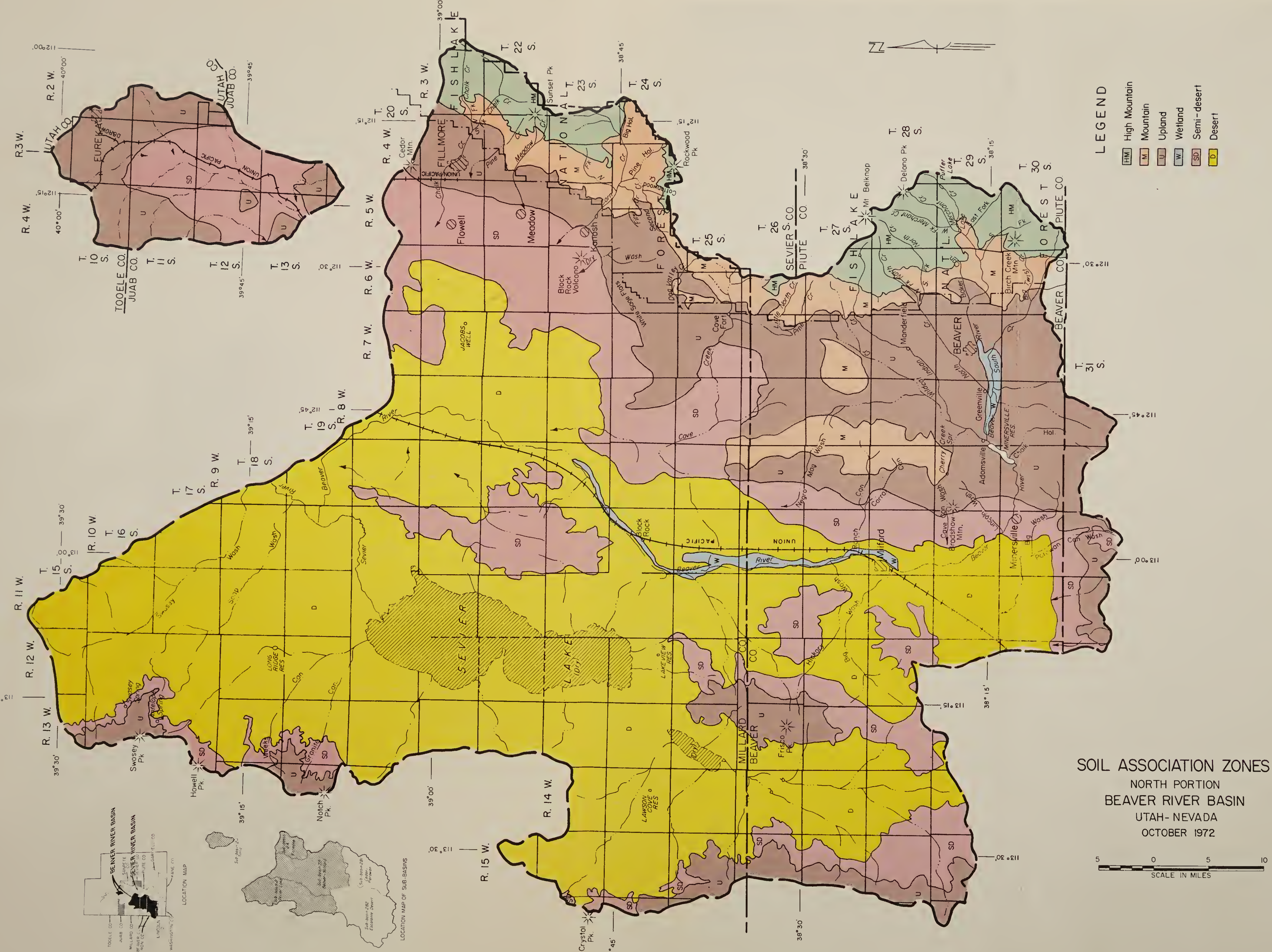
VEGETATION

Six vegetative types; conifer-hardwood, mountain brush, pinyon-juniper, sagebrush, grass, and northern desert shrub were classified and tabulated with barren and cropland excluded.

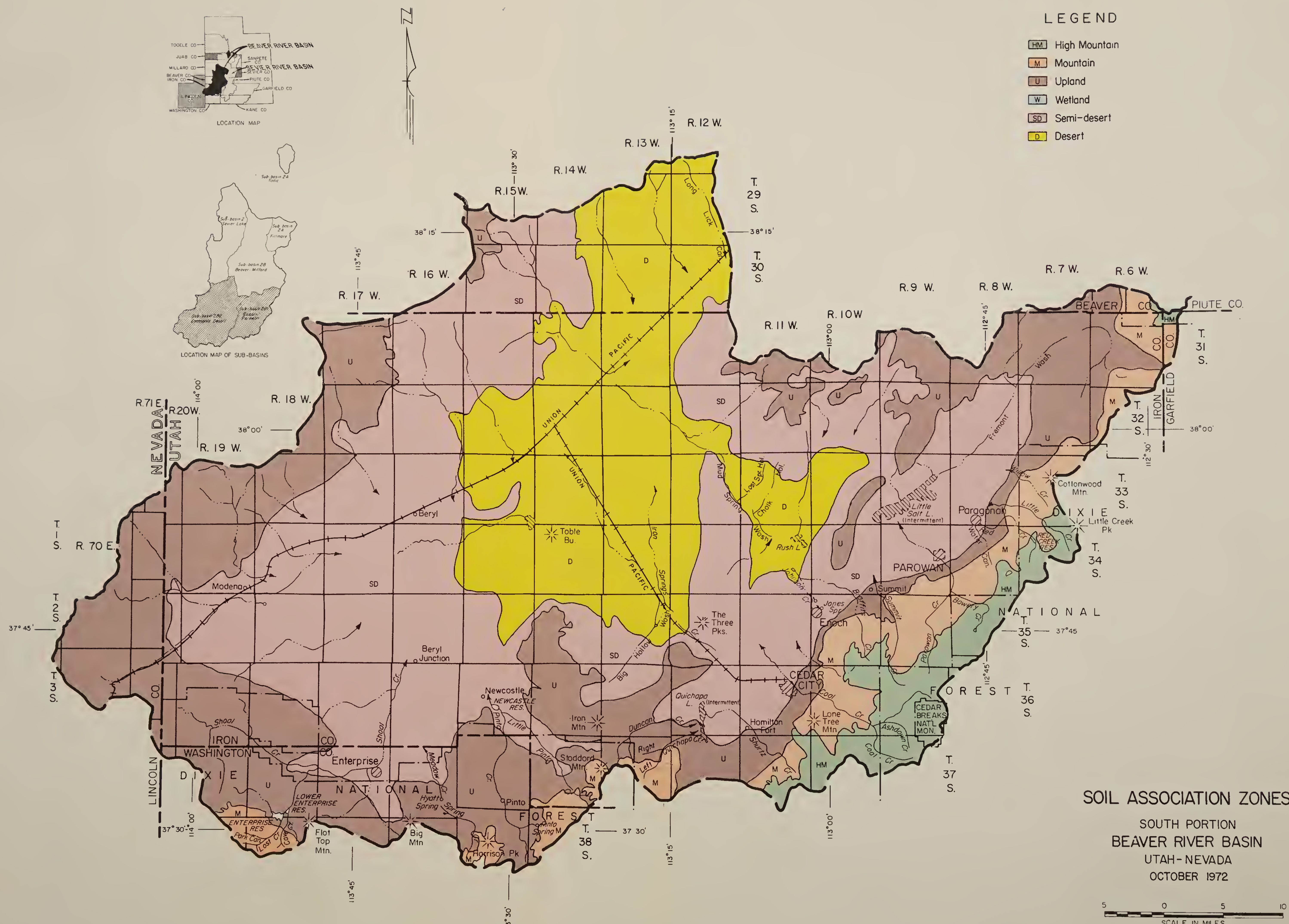
These types roughly follow from higher elevations to the valley floors and from abundant to scant precipitation. Barren areas included desert playas, recent extrusions of volcanic basalt, and areas covered predominantly with annual weeds such as pickleweed or gray molly. On the higher flanks of the Tushar Mountains, an area of rock was also included in the barren classification (Table 1 and map following page 16).

TABLE 1.--Vegetative types and other areas, Beaver River Basin, 1965

Vegetative types	Subbasin					Basin total
	Sevier Lake	Fillmore	Beaver-Milford	Cedar-Parowan	Escalante Desert	
	Acres	Acres	Acres	Acres	Acres	
Conifer-hardwood	0	26,140	77,420	62,070	2,240	167,870
Mountain brush	19,470	81,930	92,450	68,810	47,050	309,710
Pinyon-juniper	210,620	127,130	272,620	195,580	502,600	1,308,550
Sagebrush	131,710	106,340	443,560	190,640	438,770	1,311,020
Northern Desert Shrub	669,980	40,150	453,310	92,800	356,340	1,612,580
Grassland	14,890	13,640	57,190	31,080	61,610	178,410
Subtotal	1,046,670	395,330	1,396,550	640,980	1,408,610	4,888,140
Barren Land	98,490	25,100	18,060	6,780	10,070	158,500
Cropland	110	71,130	39,030	47,130	38,210	195,610
TOTAL	1,145,270	491,560	1,453,640	694,890	1,456,890	5,242,250



SOIL ASSOCIATION ZONES
NORTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA
OCTOBER 1972



SOIL ASSOCIATION ZONES

SOUTH PORTION

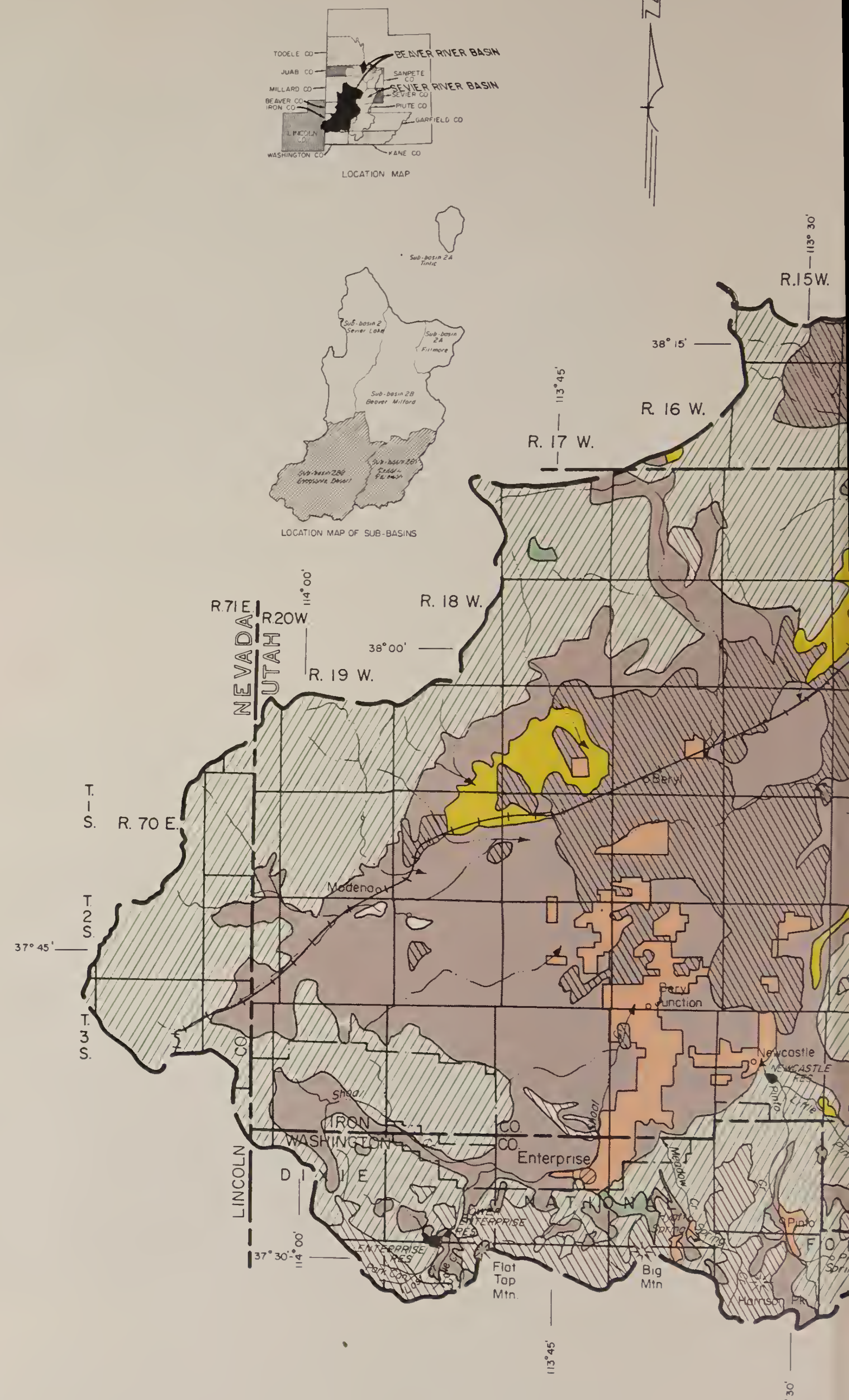
BEAVER RIVER BASIN

UTAH-NEVADA

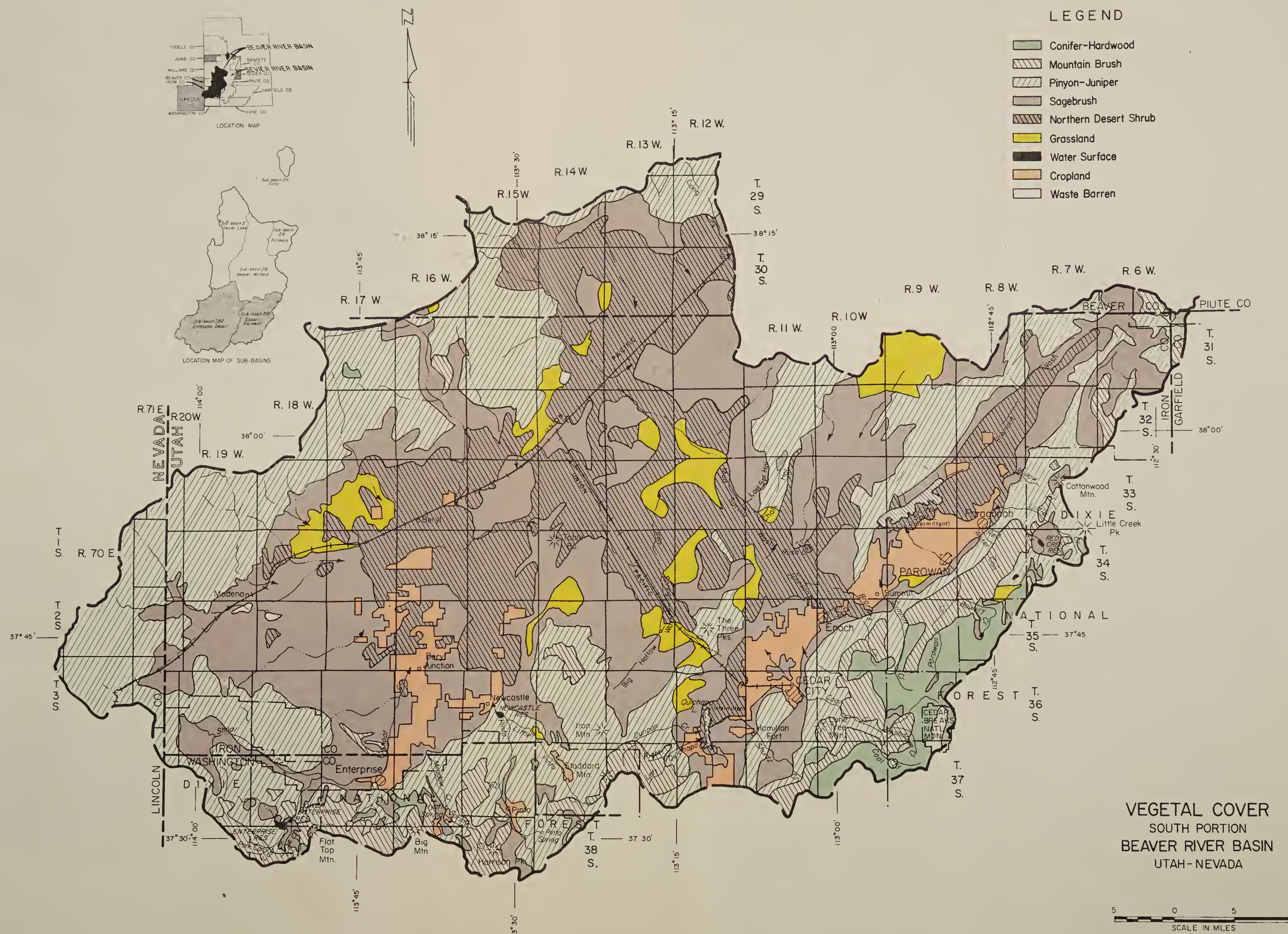
OCTOBER 1972

VEGETAL COVER

NORTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA



BEAVER RIVER BASIN
SEVIER RIVER BASIN
TOOELE CO
JUAB CO
MILLARD CO
BEAVER CO
IRON CO
SANPETE CO
SEVIER CO
PIUTE CO
GARFIELD CO
KANE CO
WASHINGTON CO
LINCOLN CO
LOCATION MAP
LOCATION MAP OF SUB-BASINS
R.15W.
R. 16 W.
R. 17 W.
R. 18 W.
R. 19 W.
R20W
R.71E
R. 70 E.
T. 1 S.
T. 2 S.
T. 3 S.
38° 15'
38° 00'
37° 45'
37° 30'
113° 30'
113° 45'
114° 00'
NEVADA
UTAH
LINCOLN
CO
IRON
WASHINGTON
CO.
CO.
DIXIE
NATIONAL
Modena
Beryl
Beryl Junction
Newcastle
NEWCASTLE RES
Enterprise
ENTERPRISE RES
Pinto
Flat Top Mtn.
Big Mtn
Harrison Pk.


LEGEND
Conifer-Hardwood
Mountain Brush
Pinyon-Juniper
Sagebrush
Northern Desert Shrub
Grassland
Water Surface
Cropland
Waste Barren
LOCATION MAP
LOCATION MAP OF SUB-BASINS
VEGETAL COVER
SOUTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA
SCALE IN MILES

Conifer-hardwood vegetation occupies mountain slopes where annual precipitation ranges from 20 to 40 inches and at elevations usually over 8,500 feet.

Mountain brush generally occurs on steep slopes where annual precipitation is 18 to 25 inches and at elevations over 7,000 feet. Mountain brush vegetation includes oakbrush, snowberry, serviceberry, rabbitbrush, bitterbrush, maple, saltbrush, and big sagebrush.

One-third of the pinyon pine and juniper acreage is in the Escalante Desert subbasin. Annual precipitation ranges from 15 to 20 inches. This vegetation is often prevalent on shallow, rocky soils.

Sagebrush is found at every elevation and precipitation range and often occupies deep, well-drained soils that are relatively salt free. Sagebrush includes silver sagebrush, black sagebrush, bud sagebrush, three tip sagebrush, low sagebrush, and the most common, big sagebrush.

Northern Desert Shrub is composed of shadscale, halfshrub, greasewood and winterfat. Shadscale occurs at elevations less than 5,000 feet, where annual precipitation is less than 10 inches. Halfshrub occurs where annual precipitation is less than 8 inches and soils typically contain hard pan or clay pan. It is characterized by semi-woody perennials of low stature such as aplopappus, fringed sagebrush, buckwheat and horsebrush. Greasewood occurs in all subbasins except Sevier Lake in almost pure stands where annual precipitation is less than 10 inches and generally in areas of salt accumulation. Winterfat occurs on deep well-drained soils where precipitation is less than 8 inches annually.

WATER RESOURCES

Water is the limiting resource to the agricultural economy. Future development and increased production will require more efficient use of existing water supplies, ground water mining, or importation of additional water. Most water resources originate within the Basin although there are some minor trans-basin surface water diversions and ground-water inflows. Ground water leaves the Basin from Cedar Valley and Pavant Valley.

Average annual precipitation within the Basin is over 4.65 million acre-feet. The surface water and ground water inflows are illustrated in Figure 1. All values are the 1956-1965 base period average except Escalante subbasin where the years 1958-1965 were used.

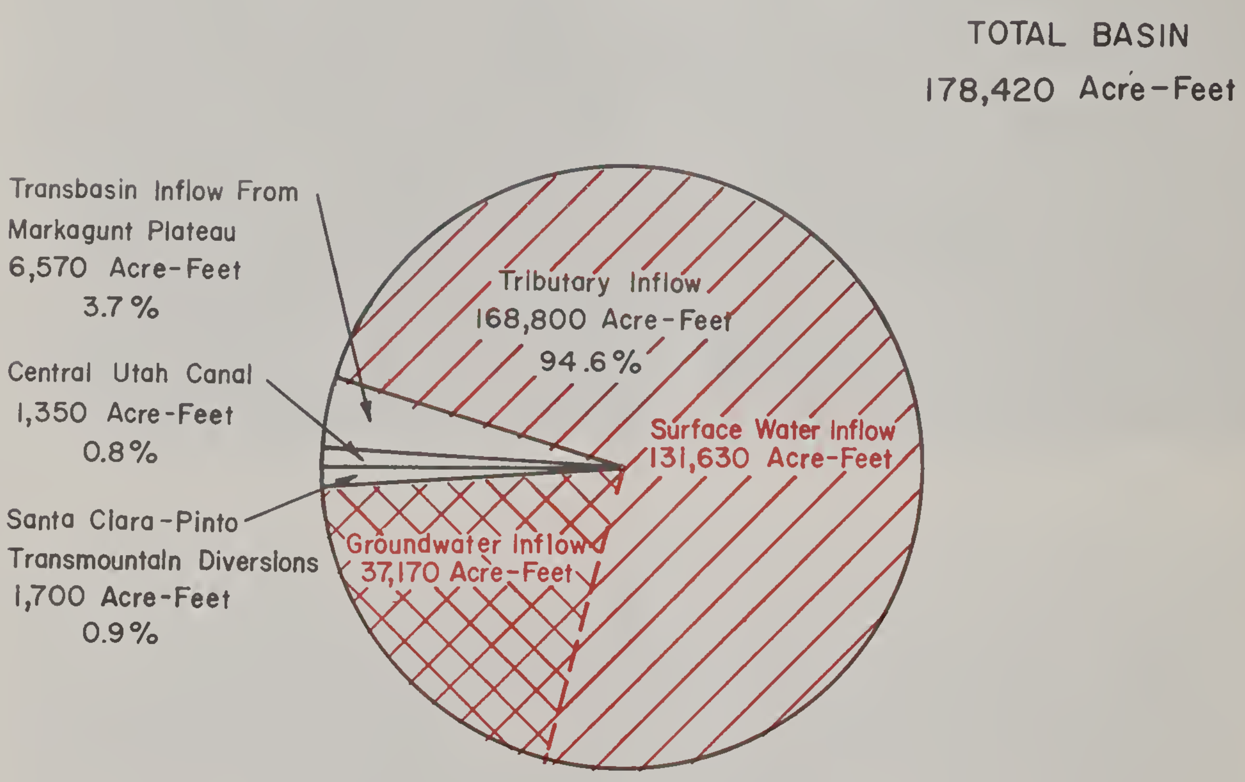


Figure 1: Annual inflow to water budget areas; Beaver River Basin, 1956-1965

SURFACE WATER SUPPLY

The Beaver River is the principal perennial stream flowing from the western flanks of the Tushar Mountains to the Minersville-Milford area where it becomes dry. Generally, all surface water flows are either diverted, become recharge to ground-water reservoirs, or consumptively used before they pass through the irrigated areas so that only flood flows reach the lower valley areas. Surface water tributary inflow averaged over 131,630 acre-feet annually, mostly from snowmelt flows. Total average yield ranges from about 0.1 inch along the foothill areas to nearly 20 inches in the Tushar Mountains. The upper watershed areas along the eastern edge of the Basin yield in the 10 to 15-inch range while those on the southern edge yield from 1 to 5 inches. Water yield in the balance of the Basin is relatively insignificant. Generally, about one-third of the total surface water flow volume occurs during May. Monthly flows decrease until September or October and then remain fairly constant through February. The variation between the peak flow months and low or base flow months is a magnitude of about 10 except the Beaver River where it is about 7.

Reservoirs have an influence on stream flow characteristics by extending flows later into summer periods. For example, regulated streams in Escalante subbasin flow about 40 percent of their volume during May and June as compared to unregulated streams in Fillmore subbasin where 54 percent of the flow volume occurs during this same period.

There are only two transbasin diversions: (1) inflow through the Central Utah Canal into Fillmore subbasin of about 1,350 acre-feet annually and (2) diversion from the Santa Clara River into Pinto Creek of about 1,700 acre-feet annually. These flows are diverted during the spring and early summer months. There are no diversions of water out of the Basin. Annual flows from the Sevier River into Sevier Lake are negligible and those that do occur result from unusual flood conditions upstream.

One of the few areas where excess tributary inflow and return flows from irrigation water diversions produce the inflow to another watershed is the Beaver and Wildcat Creek watershed flows into Minersville Reservoir. The average annual flow into this reservoir is about 18,700 acre-feet. In other areas, flows are usually contained within the watershed boundaries except on rare occasions.

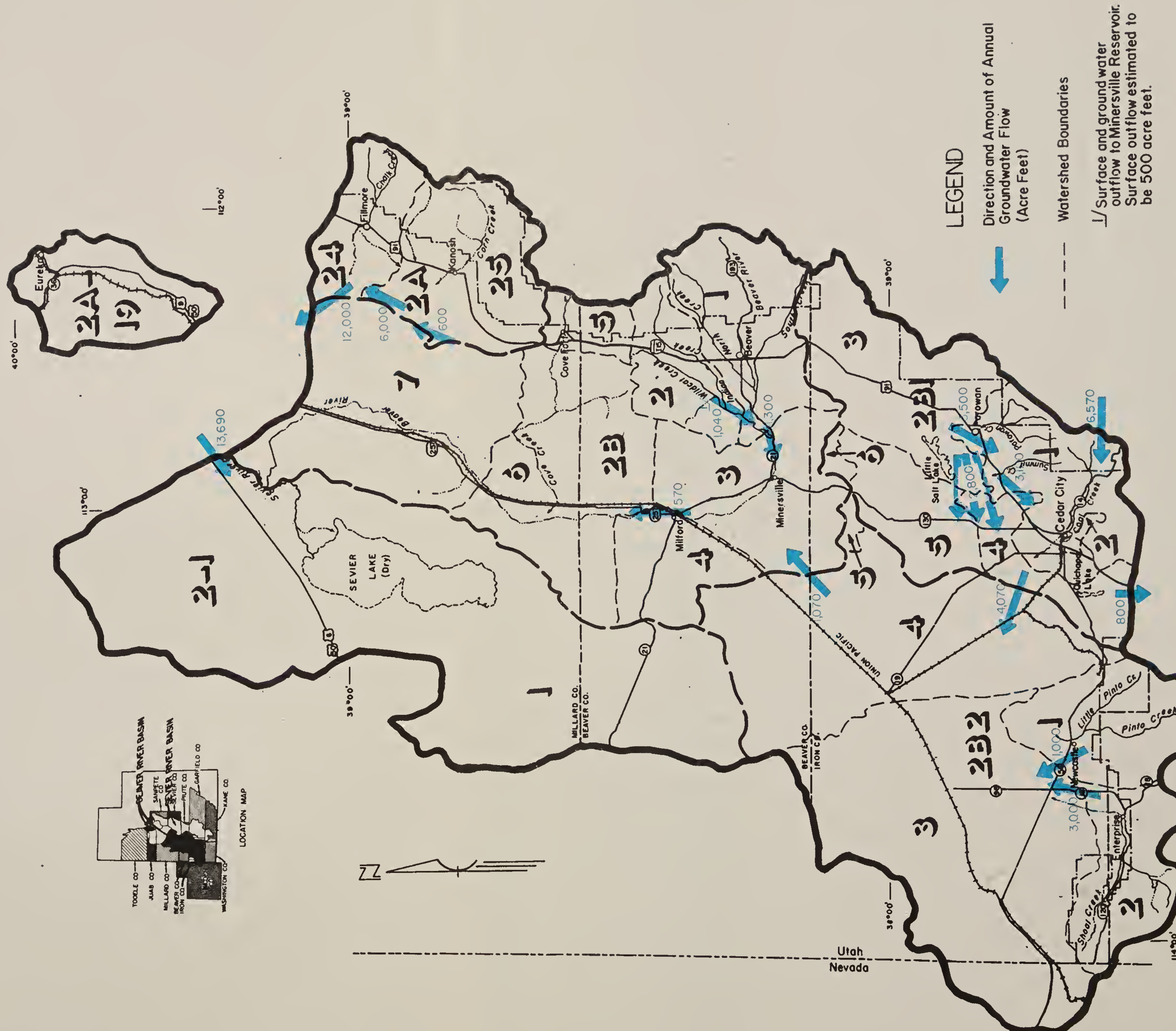
GROUND-WATER SUPPLY

The general movement of ground water is westward from the Tushar Mountains and Markagunt Plateau and northward toward Sevier Lake. Natural outlets between ground-water reservoirs are Winn Gap between Parowan Valley and Cedar Valley, Iron Springs Gap on the south and Twenty-mile Gap on the north between Cedar Valley and Escalante Valley, and Beaver River Canyon between Beaver Valley and Milford District of Escalante Valley.

Most ground water is located in five valley areas. These ground-water reservoirs are supplied from tributary ground-water inflow, ground-water movement between watersheds, and deep percolation from surface water sources. The volume of ground water in storage in Pavant Valley was estimated during 1960 at 11 million acre-feet in the upper 300 feet of alluvium. About 7.4 million of this was within the Basin boundaries. Estimates of the volume of storage in the other four ground-water reservoirs are not available.

Ground-water inflows average about 37,170 acre-feet or about 20 percent of the total tributary and transbasin inflow. The Wasatch formation capping the Markagunt Plateau yields an average of nearly 6,600 acre-feet annually to the Coal Creek watershed. The flow crosses the Basin boundary as ground water but surfaces as base flow in the upper drainage areas. Inflow from the Sevier River Basin to Sevier Lake averages about 13,700 acre-feet annually.

Although there are no strong hydrologic relationships between watersheds, small volumes of ground-water movement occur as shown on the map following page 22. Increased pumping for irrigation purposes in the Pavant, Cedar, Parowan and Escalante Valley areas during the 1956-1965 period has caused a decrease in ground-water levels. These decreased levels have flattened hydrologic gradients through natural outlets, reducing ground-water movement.



GROUND WATER FLOW

BEAVER RIVER BASIN
UTAH - NEVADA
FEBRUARY 1972

10 0 10
SCALE IN MILES

Ground water leaves the Basin from Cedar and Fillmore watersheds. Annual flow for the 1956-1965 base period is estimated at 800 acre-feet from Cedar Valley to Kannarraville. Outflow from Pavant Valley averages 12,000 acre-feet annually.

A study of surface water quality at selected points on Chalk Creek, Corn Creek, Indian Creek, and Beaver River was conducted during water year 1964.1/ Other miscellaneous measurements were made during 1969 on several small tributary streams and during 1956, 1959, and 1967 on Coal Creek.

Large volumes and concentrations of suspended sediment are transported during periods of high intensity runoff caused by summer thunderstorms and during periods of snowmelt runoff. Coal Creek yields more sediment volume than any other stream in the Basin. Measured sediment concentrations varied from 160,000 mg/l at flows of 2,400 cfs to the 4 mg/l to 10,000 mg/l level during base flow periods. Suspended sediment loads carried by the Beaver River near Beaver ranged from 2 mg/l to over 1,200 mg/l.

The dissolved solids concentration for Coal Creek ranged from about 450 mg/l to over 1,400 mg/l. Concentrations for the Beaver River near Beaver ranged from 64 mg/l to 163 mg/l at discharges of 291 cfs and 11 cfs, respectively.

Beaver and Milford discharge domestic waste water effluent into the Beaver River. The biochemical oxygen demand (BOD) of the discharged waste was 410 at Beaver and 1,400 at Milford in 1968. Cedar City discharges effluent after treatment with a BOD of 7,200 into an irrigation canal.

The ground water in Pavant Valley varies from fresh to slightly saline. Salinity increases as the water moves west and northwest. The concentrations of constituents has increased with increased use and lowering of the water table. Classification for irrigation use is medium to high salinity hazard and low to medium sodium hazard. Beaver Valley contains generally fresh ground-water supplies

1/ Hahl, D.C. and Cabell, R.E., "Quality of Surface Water in the Sevier Lake Basin, Utah, 1964". Utah Basic-Data Release No. 10, U.S. Geological Survey in cooperation with State and other Federal Agencies.

but salinity increases downstream towards Minersville. Most ground-water in Parowan Valley is fresh. Generally the sodium hazard is low but the salinity hazard is medium to high for irrigation. Cedar Valley ground-water reservoirs contain fresh to slightly saline water with the poorest quality near Coal Creek fan. Irrigation water has low sodium hazard and medium to high salinity hazard. Ground water in Escalante Valley is fresh to slightly saline with a deterioration in quality south of Milford and in the Beryl-Enterprise District. Sodium hazard is low to medium and salinity hazard is medium to high for irrigation.

FISH AND WILDLIFE RESOURCES

Fish, birds, reptiles and mammals occur in relative abundance and variety. Hunting and fishing activities utilize this resource but esthetic values of wildlife are becoming more important.

AQUATIC WILDLIFE

Game fish include Brown trout, Rainbow trout, and Cutthroat or Native trout. Nongame fish include Redside shiner, chubs, dace, suckers and sculpin. Some of the nongame fish are used as food by large Brown trout but more commonly, they compete directly with trout populations for available habitat.

Reservoirs provide over 2,000 acres of lake fishing. Fish populations are maintained by periodic stocking of fingerlings and catchable size trout. None of these reservoirs have tributary streams of suitable quality to provide natural spawning areas.

About 370 miles of stream were inventoried and classified by Utah Division of Wildlife Resources as to characteristics for fish habitat. None of the fishing streams were meadow type streams with rooted aquatic vegetation and capable of producing creel sized fish through natural reproduction. About 160 miles or 43 percent were streams unable to maintain trout populations without stocking of catchable size trout. About 130 miles or 36 percent were intermittent streams that do not provide permanent trout habitat. The remaining 21 percent or 80 miles were unsuitable for trout. This includes 60 miles of the Beaver River that is periodically dry and 20 miles of Pinto Creek.

TERRESTRIAL WILDLIFE

As an indication of the varieties of wildlife, one list contains 166 kinds of birds, 21 species of mammals, and 15 amphibian and reptiles.

Numbers of wildlife have never been inventoried. Accurate harvest records of game species are kept and estimations of numbers as well as trends are made to evaluate the affect of harvest on populations.

An evaluation was made of wildlife by ranking selected species from abundant to rare and by trend as increasing, static, or declining (Table 2). These determinations are only valid within the following framework: (1) Species are evaluated in relation to their habitat. For example, 20 acres may support a deer but 20 square miles is required to support a mountain lion family and both populations would be classified as "abundant". (2) The conterminous basin is considered as an entity despite the fact that populations may be increasing in one area and declining in another area.

TABLE 2.--Selected wildlife species evaluation by occurrence and trend, Beaver River Basin, 1970

Species	Occurrence[a]	Trend[b]
Animals		
Mule deer	Abundant	Static
Elk	Uncommon	Static
Antelope	Uncommon	Declining
Coyote	Uncommon	Static
Kit fox	Common	Static
Mountain lion	Rare	Declining
Beaver	Common	Increasing
Bobcat	Uncommon	Declining
Birds		
Golden eagle	Common	Declining
Band-tailed pigeon	Unconnom	Static
Mourning dove	Abundant	Increasing
Blue grouse	Uncommon	Static
Ruffed grouse	Common	Static
Pheasant	Common	Declining
Chuckar	Common	Increasing
Sage grouse	Uncommon	Declining
Predatory hawks	Common	Declining
Turkey	Uncommon	Static

a Abundant - More abundant than in other areas of western states
Common - Same as other western states
Uncommon - Less abundant than other western states
Rare - a rarity, species infrequently seen, often not for several years

b Based on recent (10-15 year) estimates

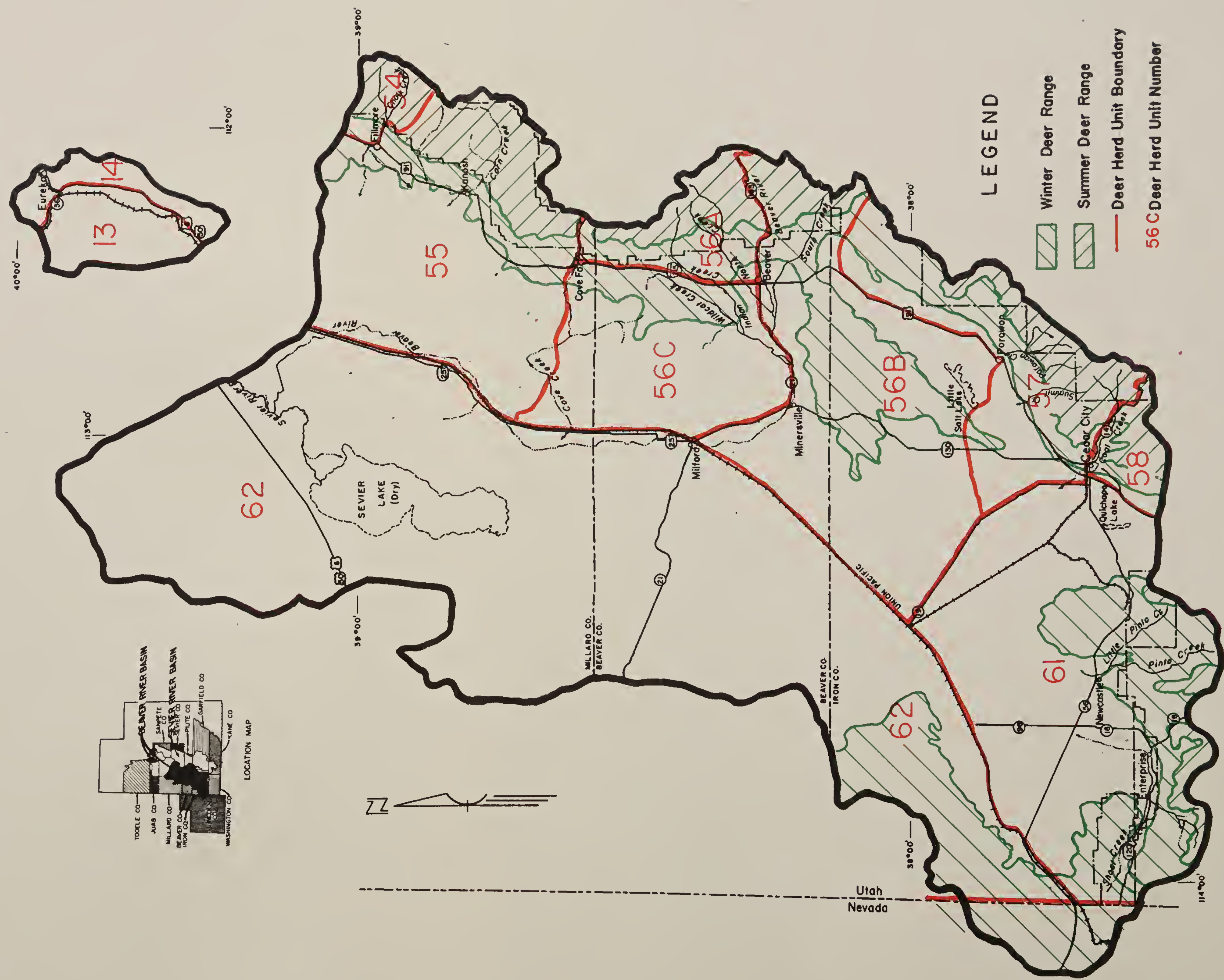
Most of the beaver, the only animals in quantity with a marketable pelt, inhabit most of the perennial streams and prefer habitat with abundant willow or aspen vegetation. Most beaver are found in Beaver watershed.

Upland game birds include pheasant, sage grouse, mourning dove, chuckar, forest grouse, and quail. Weed and brush patches, vegetated fence lines, and uncultivated areas intermingled with croplands make ideal habitat for upland game birds. Mourning doves are well adapted to the extensive areas of brush and rangeland. In the desert, their distribution is often limited by lack of water.

Mule deer are the most abundant big game. Large expanses of suitable habitat have resulted in abundant populations, making this area famous for deer hunting. The areas of summer and winter habitat are shown for 11 herd units (map following page 26). Winter habitat is the limiting factor on the eastern herd unit populations. Many of the desert mountain ranges produce only pinyon-juniper and sagebrush; here a delineation between winter and summer ranges was not made.

Antelope occur in the desert and semi-desert areas. In order to build up native herds, 145 animals were introduced during 1948. Since these animals were introduced, the populations have been static or declining.

About 80 free roaming horses and burros in some five separate bands are located in or near the Basin. These bands, of 5 to 25 animals per band, are found in the Swasey Mountains, Parowan Gap, Modena, and Iron and Mud Springs areas.



DEER RANGE AND HERD UNITS

BEAVER RIVER BASIN

UTAH - NEVADA

APRIL 1971

SCALE IN MILES

CHAPTER IV

RESOURCE USE AND MANAGEMENT

This chapter describes present and projected use and management of water, land, and recreation resources. Resource use and management projections are those that could be accomplished by about 1980 or 1985 through on-going programs. Except for recreation, the projections are based on trends established during the base period 1956-1965. Recreation projections are made with methodology similar to that used by the Bureau of Outdoor Recreation.

WATER USE AND MANAGEMENT

The proper use and management of the water resource is critical to the future of the area. Decision makers should carefully ascertain the long-term effects and priorities of water resource uses to prevent unforeseen and undesirable impacts. Increasing demands on this limited supply make it necessary to give proper consideration to both consumptive and non-consumptive uses.

ONSITE WATER USES

Onsite uses by vegetation provide watershed protection, forage for livestock, wildlife habitat, recreation opportunities, and other economic, social, and environmental values. Over 4.24 million acre-feet of precipitation falls on lands outside the water-budget areas of which nearly 4.1 million acre-feet evaporates directly or is consumptively used by on-site vegetation. Onsite consumptive uses outside the water-budget areas are shown in the following tabulation:

Subbasin		Acre-Feet
2	Sevier Lake	745,100
2A	Fillmore	414,800
2B	Beaver-Milford	1,188,300
2B1	Cedar-Parowan	596,100
2B2	Escalante Desert	1,131,700
	Basin Total	4,076,000

AGRICULTURAL WATER USES

Total average annual water supply to the water-budget areas is nearly 584,100 acre-feet from the following sources: precipitation, 405,700 acre-feet; watershed yield, 168,800 acre-feet: trans-basin flows and diversions, 9,600 acre-feet. The ground-water inflow of 13,690 acre-feet from the Sevier River to Sevier Lake was not included. The supply to the water-budget areas is one-eighth the Basin total.

IRRIGATION WATER USE

Consumptive use by irrigated crops is the largest water user within the water-budget areas. A water-budget analysis was made for each year of the base period for twelve budget areas. (Map following page 28). These budgets evaluated quantity and distribution of the water supply, consumptive use by vegetation and other miscellaneous uses, and outflow. The total potential consumptive use of the irrigated crops averages 252,500 acre-feet annually. The average actual consumptive use is 190,000 acre-feet, about 64 percent of the total water-budget area uses.

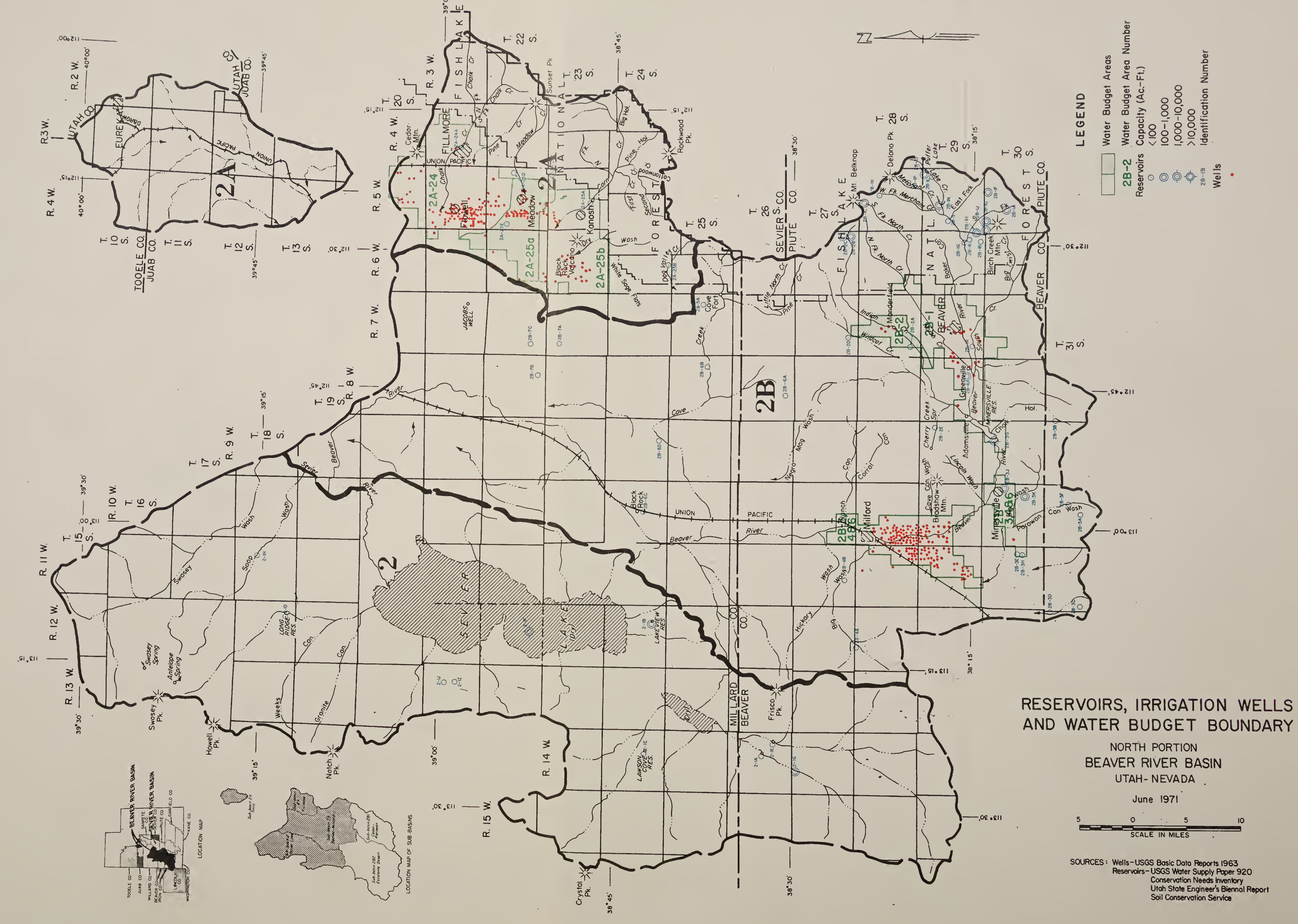
Direct use from ground water in irrigated areas occurs only in the Beaver Watershed where it averages 11,300 acre-feet annually. This situation exists on 4,900 acres, primarily irrigated pasture and some alfalfa. The base period total available supply and actual consumptive use for the irrigated areas is shown below.

Subbasin	Available Supply acre-feet	Consumptive Use acre-feet
2A Fillmore	110,600	50,800
2B Beaver-Milford	129,800	61,000
2B1 Cedar-Parowan	89,300	34,500
2B2 Escalante Desert 1/	89,000	43,700
Basin Total	418,700	190,000

1/ Eight year average (1958-65) was used for Escalante Subbasin

Wetland consumptive use averaged nearly 34,800 acre-feet on 17,800 acres. About 4,100 acres of wetlands receive some irrigation. Areas classified as wetlands have a water table within five feet of the surface. Wetlands in Beaver Valley and parts of the Parowan and Cedar Valley consume 70 percent of the total wetland water use. Consumptive use varies from one to five feet per year and averages about 1.95 feet.

Areas of native vegetation within water budget areas with water tables below 5 feet consume nearly 60,000 acre-feet of



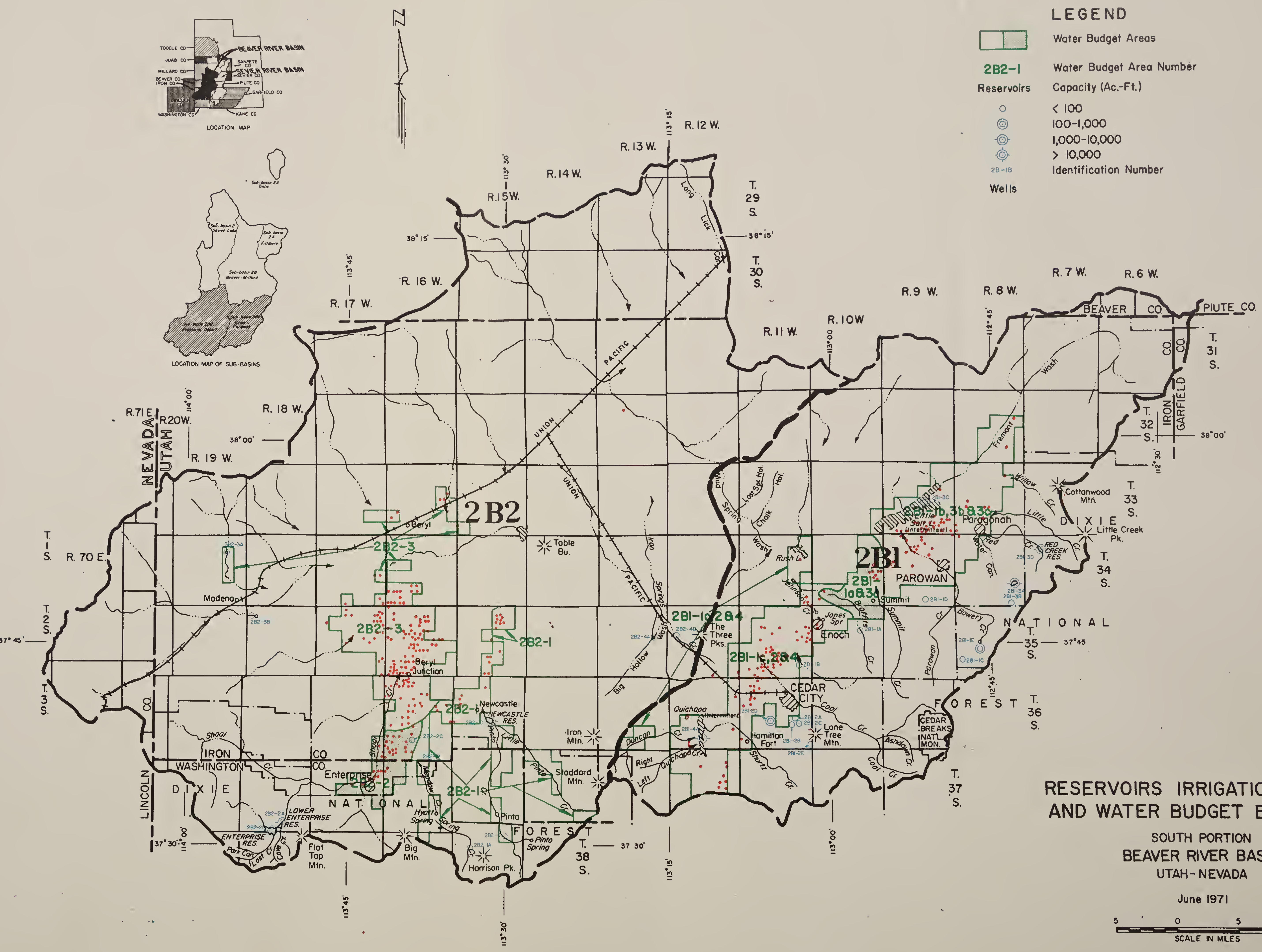
RESERVOIRS, IRRIGATION WELLS AND WATER BUDGET BOUNDARY

NORTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA

June 1971

SOURCES: Wells-USGS Basic Data Reports 1963
Reservoirs-USGS Water Supply Paper 920
Conservation Needs Inventory
Utah State Engineer's Biennal Report
Soil Conservation Service

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE



RESERVOIRS IRRIGATION WELLS AND WATER BUDGET BOUNDARY

SOUTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA

June 1971

SCALE IN MILES

SOURCES: Wells-USGS Basic Data Reports 1963
Reservoirs-USGS Water Supply Paper 920
Conservation Needs Inventory
Utah State Engineers Biennal Report
Soil Conservation Service

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

water, in addition to the precipitation that falls on these areas. This consumptive use is supplied primarily from undiverted spring runoff, irrigation tail water, and use from ground-water reservoirs by deep-rooted vegetation. Total consumptive use by wetlands and other native vegetation in the water budget areas is nearly 95,000 acre-feet annually. These are shown in the following tabulation.

Subbasin	Consumptive Use: Wetlands acre-feet	Consumptive Use: Other Native Vegetation acre-feet
2A Fillmore	2,680	20,180
2B Beaver-Milford	11,250	10,660
2B1 Cedar-Parowan	18,440	26,940
2B2 Escalante Desert 1/	2,390	2,140
Basin Total	34,760	59,920

1/ Average for 1958-65.

IRRIGATION WATER MANAGEMENT

Reservoir and lake facilities are used primarily for irrigation water storage and regulation. Total irrigation water storage capacity is about 47,000 acre-feet. Nearly one-half of this capacity or 23,000 acre-feet is located in Minersville Reservoir. The balance of the Beaver-Milford subbasin has about 4,000 acre-feet of storage capacity. Storage capacities in Cedar-Parowan subbasin are less than 4,900 acre-feet in four facilities. Nearly 15,000 acre-feet of storage in Escalante Desert subbasin is located in three reservoirs.

There are approximately 50 irrigation companies serving nearly 64,000 acres or 55 percent of the irrigated cropland. They operate and maintain 420 miles of canals and laterals with capacities up to 100 cfs. About 97 miles or 23 percent are lined. The average surface water conveyance efficiency is 69 percent, varying from 64 percent in the Beaver-Greenville area to 90 percent in the Meadow area. On-farm efficiencies served by surface water systems ranged from 31 percent in Parowan area to 50 percent in Minersville-Milford area. Conveyance systems from wells were up to 24 percent more efficient than surface systems. On-farm irrigation from wells was up to 14 percent more efficient than surface systems. The present irrigation efficiencies are shown in the following tabulation.

Subbasin	Irrigation Efficiency Conveyance percent	On-farm percent	Overall percent
2A Fillmore	77	46	35
2B Beaver-Milford	70	45	32
2B1 Cedar-Parowan	70	40	28
2B2 Escalante Desert	83	44	36
Basin Total	74	44	33

The ground-water supply for irrigation comes primarily from wells. The number of pumped wells has increased considerably since the 1940's, but the increase in number of flowing wells was moderate. The map following page 28 shows the location of wells. The volume of irrigation water supplied from wells has increased 300 percent between 1946 and 1965. Irrigation wells provide over 55 percent of the total irrigation water supply diverted. The volume of water supplied from this source varied during the base period from about 107,600 acre-feet in 1957 to about 208,300 acre-feet in 1964 with an average of 185,300 acre-feet.

Ground water has been used at a faster rate than it has been recharged. The average decrease in ground-water storage during the base period was about 36,000 acre-feet annually. Consequently, yield from flowing wells in part of Pavant Valley, Fillmore subbasin, decreased from about 17,000 acre-feet in 1946 to under 3,000 acre-feet in 1962. Flowing wells in Parowan Valley and Beaver Valley annually discharge 3,000 acre-feet and 2,000 acre-feet, respectively.

Wells such as this one near Flowell provide much of the irrigation water.

Pipelines are important features of irrigation systems.

IRRIGATION WATER IMPROVEMENTS

Irrigation water improvements were projected to 1980. These are improvements that will be made under existing programs based on past trends. It is anticipated that irrigation companies or groups will install 69 miles of open canal lining and 19 miles of pipelines. This will increase the surface water delivery efficiencies about 10 percent. Projected irrigation company canal lining is shown in the following tabulation.

Subbasin	Canal Lining 1965 miles	1980 miles	Increase miles
2A Fillmore	28	50	22
2B Beaver-Milford	13	42	29
2B1 Cedar-Parowan	42	70	28
2B2 Escalante Desert	14	23	9
Basin Total	97	185	88

In addition to canal lining, application of on-farm land treatment measures, should increase overall efficiencies about 12 percent and increase the root-zone supply by about 24,970 acre-feet. These efficiencies are shown below.

Subbasin	Irrigation Efficiency 1965	1980	Increase
	percent	percent	percent
2A Fillmore	35	46	11
2B Beaver-Milford	32	46	14
2B1 Cedar-Parowan	28	40	12
2B2 Escalante Desert	36	48	12
Basin Total	33	45	12

MUNICIPAL AND INDUSTRIAL WATER USES

Annual municipal and industrial water consumptive use, including rural and domestic uses, average about 4,210 acre-feet with 4,020 acre-feet of this use occurring within water budget areas. The remaining 190 acre-feet were consumed by rural users outside water budget areas, including Eureka. Domestic water consumptive use is estimated at 60 percent of withdrawals. Iron County industrial withdrawals were 9,000 acre-feet during 1960, while discharges during the same period were 8,350 acre-feet, indicating that industrial consumptive use was about 7 percent of withdrawals.

OTHER WATER USES

Other consumptive uses include water surface evaporation, livestock use, and wildlife uses. Non-consumptive uses generally do not have water right status. These non-consumptive uses include boating, fishing, fish and wildlife habitat, hydroelectric power generation, and other related uses.

Annual net water surface evaporation within budget areas is over 7,000 acre-feet. Over half of this amount (3,550 acre-feet) was from Little Salt Lake in Parowan Valley. Major sources of water surface evaporation not included in this estimate are Minersville, Enterprise, Newcastle, and Yankee Meadow Reservoirs. Average net water surface evaporation from Minersville Reservoir was estimated at nearly 1,600 acre-feet annually. Total annual livestock use was nearly 5,800 acre-feet. The two hydroelectric power generating plants of Parowan City Corporation are situated at Parowan and Paragonah. The plant at Paragonah utilizes water from Red Creek and the plant at Parowan diverts water from Center Creek. The four remaining hydroelectric plants are all on the Upper Beaver River system. Streamflow here is generally adequate year-round for power generation.

L A N D   U S E   A N D   M A N A G E M E N T

Lands are used within the constraints of ownership and administrative mandates for a diversity of economic and social purposes. Benefits from use accrue to individuals and the public within the Basin as well as the nation. This section discusses ownership and administration, watersheds, cropland, grazing rangeland, forest products, mining, and miscellaneous land use and management. An estimated 32,000 acres, or less than one percent of the total area is used for purposes such as urban, industrial, water storage, and transportation purposes. The Fishlake and Dixie National Forests cover 11 percent of the area; 20 percent is in municipal, county and private ownership; 8 percent is state lands; 61 percent is public domain; and Cedar Breaks National Monument and a small area of Indian trust lands near Kanosh comprise less than one percent. (Figure 2, map following page 34).

BASIN TOTAL 5,242,250 Acres[a]

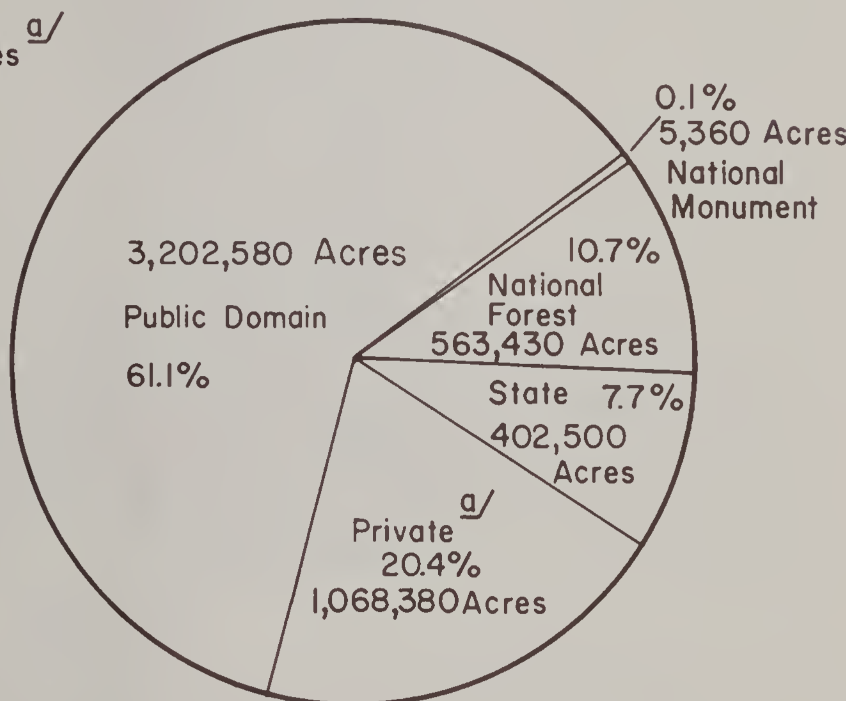


Figure 2: Land ownership and administration, Beaver River Basin, 1965

[a] Includes 1,600 acres of Indian Trust lands.

WATERSHED MANAGEMENT

Watershed management implies judicious use of resources in a manner that enhances soil protection and improves hydrologic characteristics. Range seeding, improved livestock management, proper road and trail alignment and stabilization, and rehabilitation of disturbed areas all protect watershed values.

The Bureau of Land Management has initiated watershed studies on public domain lands to ascertain their present erosion condition. Erosion conditions will be classified as stable, slight, moderate, critical, or severe. This information will be used by BLM to determine watershed treatment priorities and problem complexity. Watershed stabilization measures accomplished on National Forests during 1961-1967 are listed below:

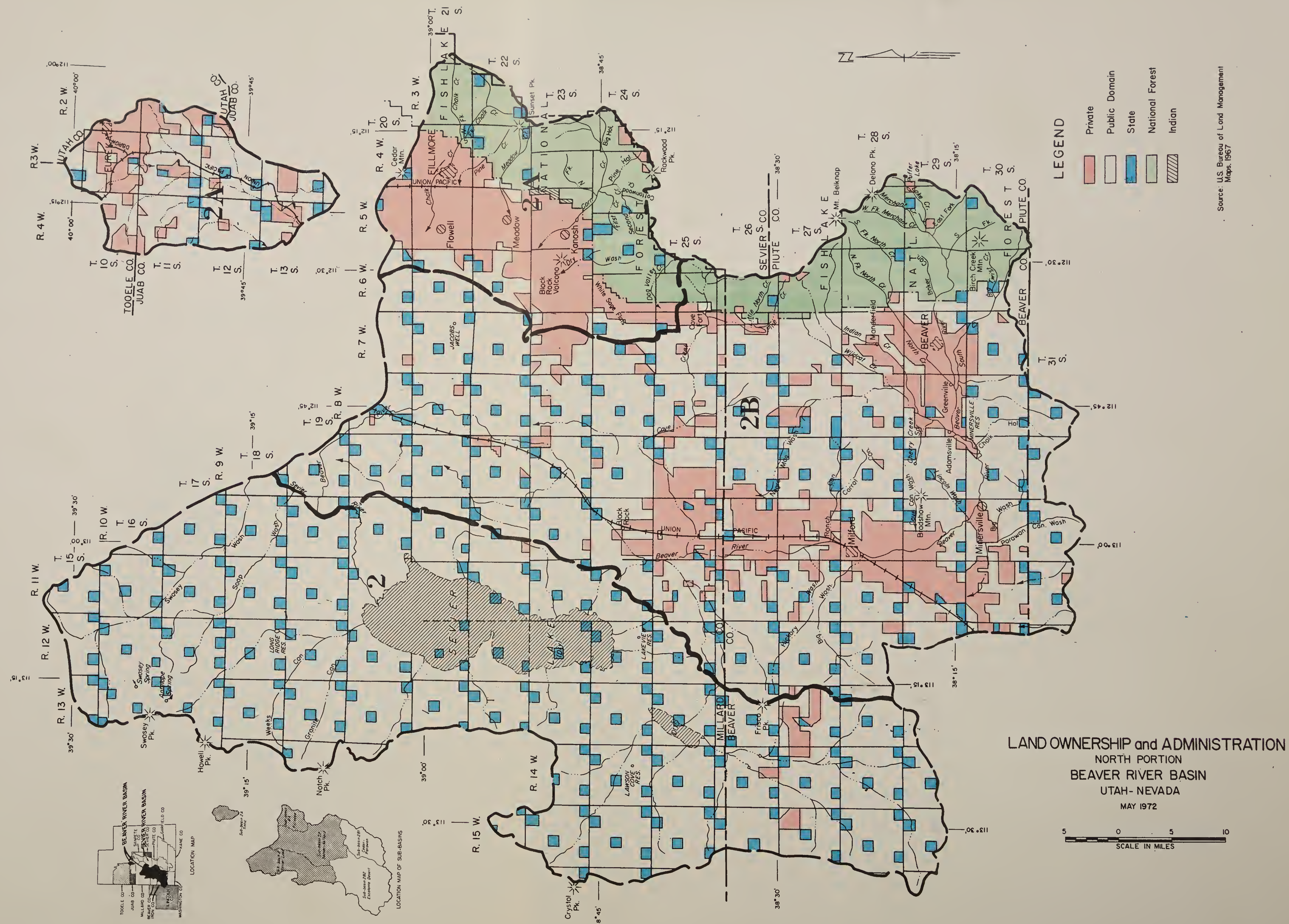
Stabilization Measures	Acres
Contour trench	2,380
Sagebrush spray and seed	900
Broadcase seed	420
Dixie harrow and seed	650
Burn rehabilitation	3,230
	Miles
Gully plugs	3
Protective fence	3

In addition to this land treatment on National Forests, intensive hydrologic analysis has been conducted on Coal Creek and Chalk Creek watersheds to determine future stabilization needs. Considerable range seeding, brush control and other land treatment has been accomplished on private lands. However, virtually none has been applied specifically for watershed protection and management.

CROPLAND

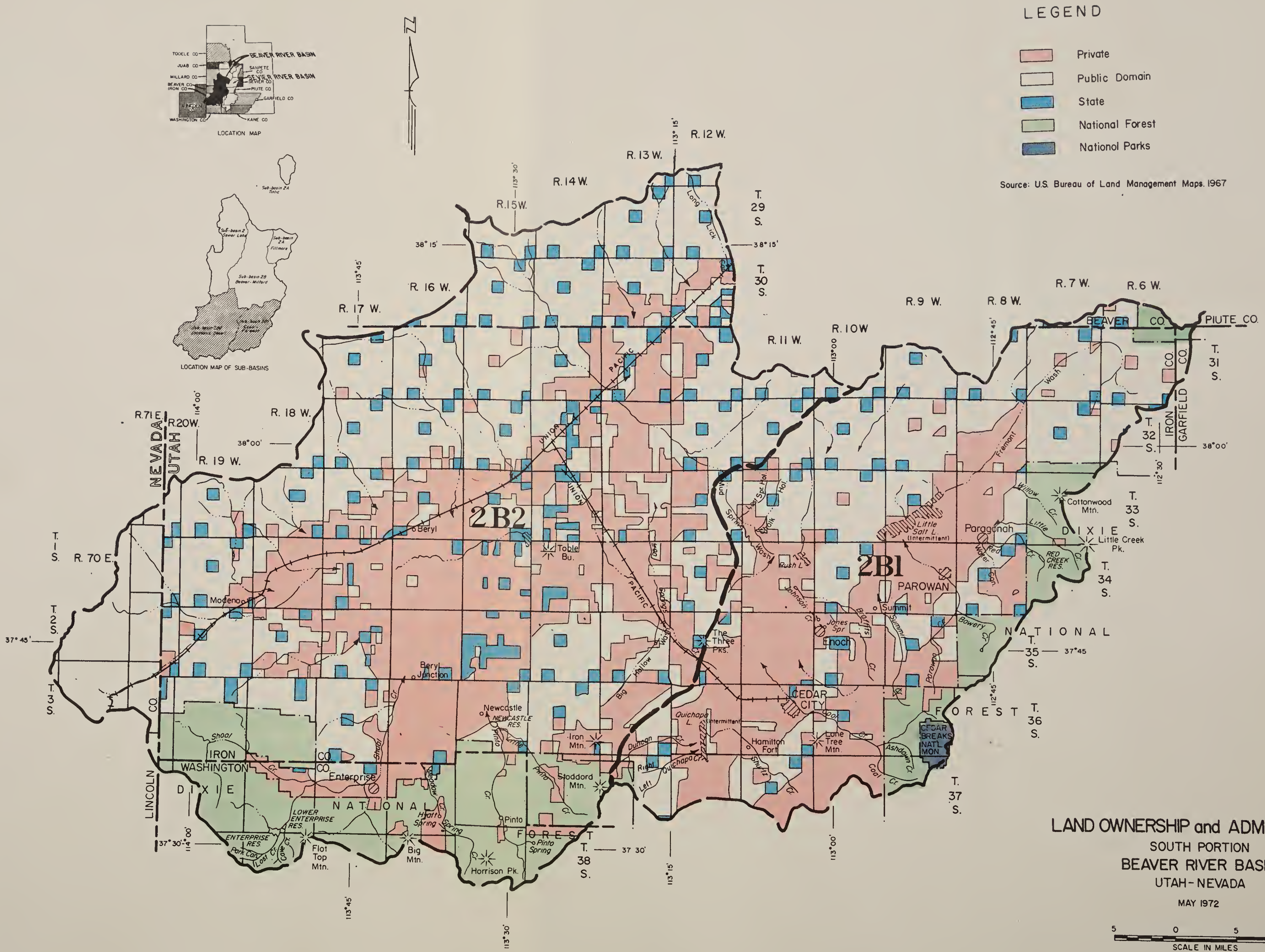
Croplands comprise 3.7 percent of the Basin area and 18.4 percent of the private land area, totaling 195,610 acres. Existing cropping patterns are expected to continue essentially unchanged. Climate, water supply, and soils limit the types of crops that can be grown.

Of the total cropland, 58.8 percent or 115,220 acres is irrigated cropland. Alfalfa is the major crop and is harvested primarily as hay, although some alfalfa seed is harvested. Small grain is grown extensively, and potatoes and sugar beets are common



LAND OWNERSHIP and ADMINISTRATION
NORTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA
MAY 1972

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE



LAND OWNERSHIP and ADMINISTRATION
SOUTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA
MAY 1972

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

in the Escalante Valley. Some idle land is in rotation with crops and other once irrigated lands have been idle more than three years (Figure 3).

Nonirrigated cropland comprises 41.2 percent of total cropland acreage or 80,390 acres. Most dry farmland producing wheat and barley is located in the Fillmore subbasin. Other nonirrigated cropland produces forage crops such as grasses and legumes; much of this acreage is in conservation reserve. About 22 percent of the idle acreage produces a crop one year out of three and the remainder has not produced a crop for a longer period (Figure 4).

No significant Basin-wide trends in types of treatment are apparent except for an increase in sprinkler system installation and a decrease in land leveling. Accomplished and projected treatment is indicated by Table 3. Land treatment on nonirrigated cropland is limited mainly to the dry farmlands of the Fillmore subbasin. In 1965, about 3,000 acres were being cultivated on the contour and 2,500 acres were being stubble mulched. Strip cropping and terracing are not being used. By 1980, if current trends continue, there will be 5,500 acres cultivated on the contour and 4,700 acres of stubble mulching.

TABLE 3.--Existing and projected on-farm treatment measures on irrigated cropland, Beaver River Basin, 1965 and 1980

Conservation practice	Unit	Subbasin: Fillmore	Beaver-Milford	Cedar-Parowan	Escalante Desert	Total
Existing						
Field ditch reorganization	Miles	149	204	81	100	534
Land leveling	Acres	14,500	12,400	10,700	13,200	50,800
Ditch lining	Miles	49	38	28	59	174
Pipelines	Miles	13	19	5	15	52
Irrigation structures	Number	7,300	6,600	2,600	3,000	19,500
Sprinkler systems	Acres	1,100	700	600	700	3,100
Projected						
Field ditch reorganization	Miles	188	219	113	138	658
Land leveling	Acres	19,000	18,100	13,800	17,250	68,150
Ditch lining	Miles	93	123	39	80	335
Pipelines	Miles	46	30	22	42	140
Irrigation structures	Number	13,750	16,600	5,600	7,500	43,450
Sprinkler systems	Acres	4,500	3,700	3,900	4,700	16,800

BASIN TOTAL 115,220 Acres

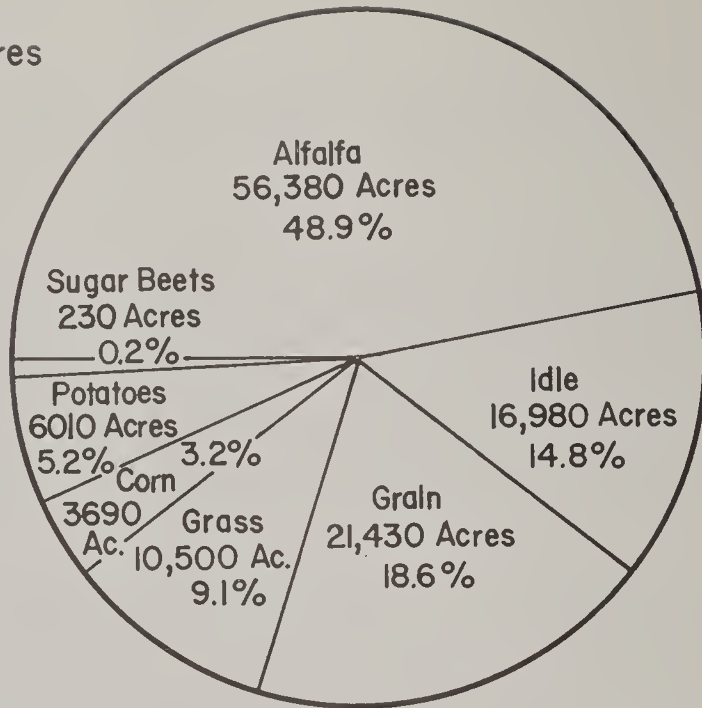


Figure 3: Irrigated land cropping patterns, Beaver River Basin, 1965

BASIN TOTAL 80,390 Acres

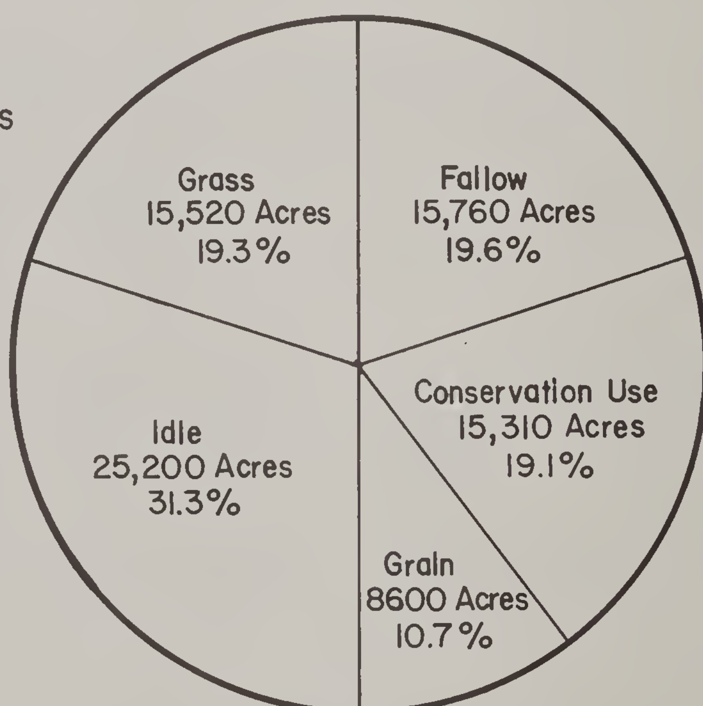


Figure 4: Non-Irrigated land cropping patterns, Beaver River Basin, 1965

RANGELAND GRAZING

Rangelands include areas of native vegetation or introduced forage species grazed by domestic livestock. Cultivated areas and irrigated pasture were not considered as rangeland. Of the total basin area, 4,207,810 acres or 80 percent is suitable for livestock use. At the turn of the century grazing was unrestricted and transient herds competed for feed with local livestock causing rapid and extensive range deterioration. By the 1930's, controls were established on all public lands. Based on present condition of rangelands in relation to their potential, 3 percent are in excellent condition, 7 percent good, 63 percent fair, 26 percent poor and one percent in very poor condition.

Over one-half the livestock use occurs on public domain. These lands produced 219,000 AUM's (animal unit months) of grazing on 2.8 million acres in 1967. Comparable figures for other categories of land are indicated in Figures 5 and 6. In 1967, livestockmen with base property in the Basin had 422 grazing permits on National Forest and public domain lands, both within and without the Basin area. Actual use of these permits was 164,100 AUM's or 75 percent of the permitted use. Part of this non-use results from livestockmen voluntarily withholding livestock while range improvement programs were underway.

The trend of permitted grazing on public lands has been downward. On National Forests lands, permitted grazing declined 8 percent between 1950 and 1960 and then increased slightly through 1967. On public domain lands, reductions in permitted use of about 11 percent were made between 1955 and 1967. There has also been a significant shift in class of livestock. Between 1940 and 1964 sheep declined 54 percent and cattle increased 149 percent. Most of this change took place in the five year period, 1940 to 1945.

Based upon a continuation of range improvement at current levels, there will be increases in livestock by 1985. These increases amount to 6 percent on National Forests, 2 percent on public domain, and 6 percent on private lands.

Range improvements on public lands are installed through cooperative efforts of grazing permittees and land managing agencies. On National Forests in 1965, there were 135 reservoirs, 115 troughs, wells and pipelines, 383 miles of fence and 17,215 acres of forage improvement. By 1985, if current trends continue, there will be 25 additional reservoirs, 27 additional troughs, wells and pipelines, 45 additional miles of fence and 15,194 additional acres treated for forage improvement. On public domain in 1970

BASIN TOTAL = 393,360 AUM's

Figure 5:
Livestock grazing on rangelands, 1967, Beaver River Basin

BASIN TOTAL = 4,207,810 Acres

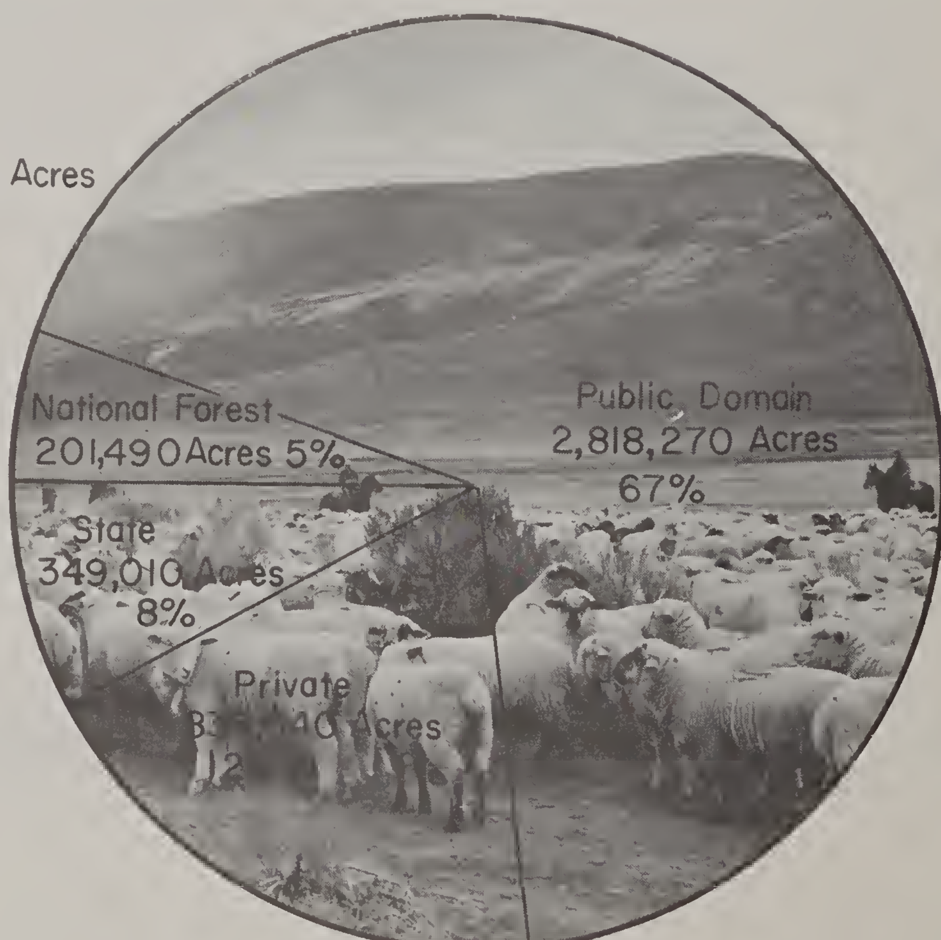


Figure 6:
Area suitable for livestock grazing, 1967, Beaver River Basin

Range facilities such as stockwatering troughs (above) and small reservoirs (below) allow better distribution of livestock and proper utilization of range forage.

there were 25 developed springs, 1,282 miles of fence, 166 reservoirs, 49 wells, 100 miles of pipeline and 96,870 acres treated for forage improvement. By 1985, if current trends continue, there will be an additional 168 water developments, 438 miles of additional fence and 77,630 acres additional forage improvement. On private lands in 1965 there were 59,930 acres of forage improvement, 830 miles of fence and 1,005 water developments. By 1985, if current trends continue, forage improvement will be installed on 19,990 additional acres; there will be 461 miles of additional fence and 1,160 additional water developments.

FOREST PRODUCTS

Forest products harvested annually include sawtimber, posts, poles, firewood, Christmas trees, ornamental trees, and pinyon pine nuts (Table 4). About 94 percent of the sawtimber is harvested in the Beaver Watershed and is usually shipped outside the Basin to Panguitch for processing.

TABLE 4.--Average annual forest products harvested (1963-1967), Beaver River Basin[a]

Product	Sawtimber	Posts	Poles	Firewood	Christmas trees	Ornamental	Pinyon Pine Nuts[b]
	Mbm	Each	Each	Cords	Each	Each	Lbs.
National Forests							
Juniper		7,730				5	
Subalpine-fir	60		20		460		
Aspen				50			
Engelmann spruce	1,460	140	1,740		1,040	12	
Pinyon pine					310	2	
Douglasfir	40						
Total	1,560	7,870	1,760	50	1,810	19	
Public domain							
Juniper		7,700					
Pinyon pine				50	700		1,300
Total		7,700		50	700		1,300
State lands							
Pinyon pine					240		
Total all lands	1,560	15,570	1,760	100	2,751	19	1,300

[a]No information available on private lands.

[b]Pinyon nut harvest includes only commercial operations, many additional pounds are collected for recreation.

Aspen logs are cut into bolts, transported to Cedar City, and converted to excelsior.

There are two small forest-based industries. At Cedar City, an excelsior plant annually converts about 3,000 to 5,000 tons of aspen to excelsior. Most of this aspen is obtained outside the Basin. Excelsior is shredded wood used as packing material and in the manufacture of cooling pads for air conditioners. A small sawmill, also at Cedar City, produces about 100,000 board feet of lumber annually. Limited markets and access, low value timber species, esthetic, and watershed considerations will continue to constrain utilization of forest resources.

MINING

Mining has been an important use of the resources and is expected to continue in importance in many areas. The Tintic District has produced more than 1,000 tons of copper, and over 2½ million troy ounces of gold. The copper, gold, lead, zinc, and silver values total nearly $332 million. During recent years production from the district has steadily declined. Halloysite clay is the most important non-metallic mineral produced in the district with an average annual output of nearly 60,000 tons valued in excess of $1 million. Commercial grade deposits of silica are mined but production figures are not available.

Cinder production has been 35,000 to 45,000 tons annually and is expected to continue for sometime. Pumice and perlite have been produced from various areas and the potential for future production is excellent. Limestone, dolomite and travertine have been produced from one area but production has stopped, although large amounts of material still remain.

Gypsum and gypsite have been produced intermittently for many years. There is an estimated 450,000 tons of gypsum on White Mountain and gypsite extends over an area of several square miles south of this mountain. Both minerals are used for a soil conditioner.

Tungsten was produced during the 1951-1956 period and represented three-fourths of the total mineral production for Millard County in 1955.

For many years, subsequent to 1875, the Frisco District and adjacent districts were heavy producers of gold, silver, copper, lead, and zinc. In recent years, only one open-pit mine has produced significant quantities.

Uranium claims are common, however no production has been reported in recent years. Fluorite occurs at several localities and has been produced recently. Extensive sulphur deposits at Sulphurdale have been worked at various times for many years. A mill built in 1961-1962, produced over 2,000 tons in 1965, and shut down in 1966 when the owner died.

Large areas in the southern part of the Basin are underlain with iron ore deposits. In 1957, the Iron Mountain area reserves were estimated at 350 million tons of which 100 million tons were classified as recoverable. All-time production to 1965 was over 72 million tons. A $1.3 million ore reduction plant has been completed by one company.

Oil and gas have been found in commercial quantities, but the total extent is not known. Several thousand acres are presently under lease in the eastern part of the Basin.

Approximately 5,200 acres have been classified as a known geothermal resource area and 830,000 acres as prospectively valuable. Coal production for 1964-1965 from Iron County was nearly 90,000 tons. Approximately 7,000 acres have been classified as prospectively valuable for coal.

OUTDOOR RECREATION

The Basin contains a diversity of recreation resources. Many new economic opportunities will be created by future growth of recreation and tourism. This growth results from increases in leisure time and income levels combined with better transportation facilities. Increasing population and environmental deterioration at the more populous areas influences people to seek quality recreation experiences. The map following page 114 indicates the locations of many existing recreation sites.

The Sevier Lake subbasin is characterized by rolling hills and a desert playa. Swasey Peak and Notch Peak are over 9,000 feet in elevation, rising steeply from the desert floor on the east, with an abrupt drop to the west. Antelope Springs and Fossil Mountain are popular sites for collecting trilobite fossils. The ghost town of Frisco sheltered miners who worked the Horn Silver Mine north of Frisco Peak.

The Tintic watershed has two areas of natural interest. Paul Bunyan's Woodpile is a massive rock formation appearing as an immense stack of petrified cordwood all cut to stove length for some mammoth cookstove. The Little Sahara, an area of sand dunes, is the most heavily used recreation site administered by Bureau of Land Management in the State of Utah. Development plans include a water system, road system, camping and picnicking facilities, sanitation facilities, play areas for children, areas for competitive and general use of motorcycles and dune buggies. When fully developed the Little Sahara site will be capable of accommodating nearly 75,000 people at one time.

Four campgrounds have been developed along Chalk Creek. People are attracted to these cool canyon retreats and enjoy the esthetics of the canyon and shady riparian vegetation. Fillmore, the principal city in the Chalk Creek watershed, was the first capital of Utah. Capital buildings and many historic artifacts are displayed for visitors.

Crystal peak in the Sevier Lake subbasin is one of many scenic attractions in the desert area that are seldom visited.

Adelaide Park, in the Corn Creek watershed, is a modern campground with a capacity for 200 people. White Mountain, on the west side of this watershed, named for the deep white beds of gypsum sand is a favorite picnic site. Near Meadow, a private ranch is catering to recreationists. Three small fishponds have been constructed and the 200-acre ranch provides opportunities for participation in rural life activities.

The principal attraction, in Cove Creek watershed, is the well preserved "Old Cove Fort" constructed in 1867. It is 100 feet square with walls 10 feet high. The fort was built to protect nearby stagecoach and freightline routes and is located on what was known as the "Mormon Trail."

Numerous reservoirs, clear streams, and alpine scenery attract many recreation visitors to the Tushar Mountains. There are 10 National Forest campgrounds with a capacity for 635 people. A roadless area of 36,000 acres has been identified for study as a potential wilderness area. Other facilities on the National Forest include a commercial public service site, a summer-home area, and an LDS Church camp. Existing private development includes summer-home tracts near LaBaron Reservoir and Merchant Creek, on the South Fork of the Beaver River, and at the mouth of

Beaver Canyon. Beaver City has developed a nine-hole golf course, race track, open-air swimming pool, and related facilities. The Daughters of the Utah Pioneers maintain a museum and information center that is open during the summer months.

Minersville Reservoir is a popular fishing site and a state boating park provides boat launching, sanitation and picnic facilities. The Mineral Mountains provide spectacular scenery and are rich in mining lore. The Bureau of Land Management has developed limited picnic facilities at Rock Corrall, a natural rock enclosed amphitheater.

The primary attraction in Coal Creek watershed is Cedar Breaks National Monument with its huge amphitheater eroded into the multi-colored Wasatch geological formation. Facilities include a lodge, picnic and campground areas, and interpretive services. Just below the monument, 8,500 acres of the Ashdown Gorge has been identified for study as a potential wilderness area. A drive through Parowan and Cedar Canyons is a spectacular trip. National Forest developments include Cedar Canyon and Vermillion Castle campgrounds. Developments in Cedar Canyon also include an archery range and a county picnic and outdoor activity area. The Brian Head ski area and summer homes are on private and National Forest lands. Other private recreation development includes Co-op Basin near Parowan, and Summit Estates summer-home development. Municipal developments at Cedar City include a swimming pool, golf course, city park, ball fields, fair and rodeo grounds, and other related facilities. Municipal developments at Parowan include a swimming pool, city park, and other facilities.

Newcastle Reservoir in Pinto Creek Watershed is popular for fishing. Summer and retirement homes are being developed along Meadow, Pinto and Little Pinto Creeks. Old Irontown is the site of early pioneer ironworks. Two historic towns, Holt and Hamblin, on the Old Spanish Trail, have been abandoned and only cemeteries remain.

In Shoal Creek Watershed, the Upper and Lower Enterprise Reservoirs provide scenic and fishing attractions. The reservoir dams are interesting examples of pioneer engineering and construction. Honey Comb Rocks campground is located near the upper reservoir on Dixie National Forest.

Skiing at Brian Head in the Cedar-Parowan subbasin is increasing in popularity.

PRESENT AND PROJECTED RECREATION USE

Total outdoor recreation in the Beaver River Basin was estimated to be 502,000 visitor-days1/ in 1969 compared to 284,000 visitor-days in 1959. This represents an annual increase of seven percent. The most rapidly growing segment of recreation demand is from out-of-state visitors. In the vicinity of Cedar City, Utah State Highway Department data indicate that in 1960, 38 percent of the passenger cars in average daily traffic were from out of state. By 1967 this had increased to 63 percent. At a campground near Cedar City, license plates were checked on weekdays weekends. On weekdays California cars comprised 59.0 percent of the sample, Nevada cars 17.7 percent and Utah cars 12.8 percent. On weekends, California cars comprised 34.1 percent, Nevada cars 27.6 percent and Utah cars 26.3 percent of the total.

1/ A visitor-day consists of a recreational activity for a twelve-hour period (twelve people for one hour or one person for a twelve-hour period).

Visitor-days of recreation use on National Forests increased from 123,880 in 1959 to 179,620 in 1965 and are projected to increase to 224,100 by 1980. A comparison of 1959 and 1965 data indicates increases in hiking and riding, use of commercial resorts, winter sports, and sightseeing; conversely, picnicking, fishing and hunting all decreased. Also, the use of commercial developments, lakes and reservoirs, roads and trails and campgrounds all increased. Conversely, use of rivers and streams and undeveloped areas decreased. Based on this information, it appears that people prefer activities oriented to some form of development.

Recreation use ofpublic domain is increasing at a more rapid rate than on other lands. The 1965 recreation use on public domain was 124,500 visitor-days and this is expected to increase to 224,000 visitor-days by 1980. Table 5 indicates present and projected numbers of visits by recreation sites.

TABLE 5.--Estimated recreation visits[a] on public domain recreation sites, Beaver River Basin

Sites	Present visits 1970	Estimated number of visits by year 1980
Antelope Springs Area	2,000	5,000
Crystal Peak	500	800
Little Sahara	100,000	300,000
Paul Bunyon	1,200	2,500
Rock Corral	1,000	3,000
White Mountain	1,200	2,000
Minersville Reservoir	74,000[b]	150,000

[a]Note: "visits" are not the same as "visitor-days".
[b]One-half use on Bureau of Land Management land.

The 1965 recreation use at Cedar Breaks National Monument area was 77,500 visitor-days. This use is expected to increase to 141,900 visitor-days in 1980.

Outdoor recreation is difficult to define for state, private, municipal and county areas. Little information is available, and decisions as to types of activity to be included add to the complexity. The figures used are estimates of participation in more formal recreation activities, such as golfing, swimming, and dude ranch activities. They are considered conservative. In 1965 use was estimated to be 29,000 visitor-days on private lands and 57,000 visitor-days on municipal, county and state areas. Projections are for 52,000 visitor-days by 1980 on private lands and 105,000 visitor-days on state, county, and municipal areas.

Camping and picnicking are popular outdoor recreation activities.

FISHING AND HUNTING

About 32 percent of outdoor recreation is related to fishing and hunting. In 1965 this use was estimated to be 130,600 visitor-days. By 1980 this is expected to increase to 191,200 visitor-days annually, but it will decrease to about 26 percent of total outdoor recreation.

Fishing provided 61,200 man-days of recreation in 1965 and this use is expected to increase to 101,600 man-days by 1980. Fishing is popular at reservoirs constructed primarily for irrigation water management. Minersville Reservoir is the most popular fishing reservoir in the Basin. Stream fishing is more popular in the Beaver River watershed than on any other area. Streams in this watershed are the only ones with sufficient stability and quality to support permanent fish life. Fish are planted on a put-and-take basis in other streams.

Minersville Reservoir is the most popular fishing reservoir in the Basin.

Manderfield reservoir receives little recreation use due primarily to the lack of facilities and difficult access.

Hunting was estimated to provide 69,000 visitor-days of outdoor recreation activity in 1965 and this use is expected to increase to 89,600 visitor-days by 1980. This increase is much less than that predicted for other outdoor recreation activities. Deer, antelope, upland game birds, and rabbits provide the major hunting opportunities. Waterfowl and other game are limited, but do provide some hunting opportunities.

The area is noted for deer hunting opportunities and large deer herds. Harvest information shown in Figure 7 indicates trends in this activity. The percentage of out-of-state hunters in proportion to Utah hunters has increased from 40 percent in 1958 to 54 percent in 1967. Total deer-kill is in a downward trend. Key game ranges were overstocked causing resource damage, hence liberal hunting regulations were adopted to bring herd numbers in balance with habitat. Total deer killed exceeded the number of hunters in 1960 as 13,700 hunters killed 19,950 deer or 1.45 deer per hunter. At this time there were many multiple deer hunts. in 1964 the number of hunters and deer killed were nearly equal and by 1967 only 0.74 deer per hunter was killed.

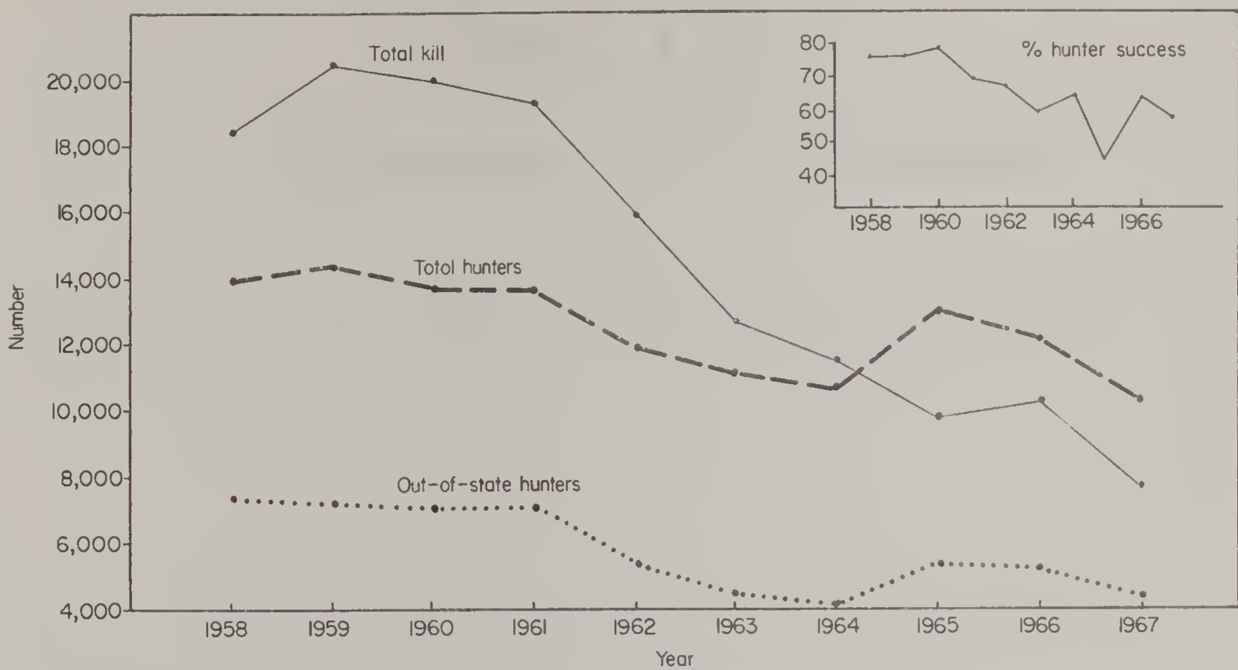


Figure 7:
Total deer killed, number of hunters, and hunter success, Beaver River Basin

Source: "Utah Big Game Investigations and Management Recommendations" Annual Report, 1958 through 196[illegible], published by Utah Division of Fish and Game, Department of Natural Resources.

Upland game birds in the Basin include pheasant, mourning dove, chukar partridge, sage grouse, forest grouse and quail. The average annual hunters afield and the total harvest for the 1964-1967 period in Iron, Millard, and Beaver Counties is shown in the following tabulation.

	Average No. of Game Bird Hunters	Average No. of Game Birds Harvested
Pheasants	4,626	12,206
Mourning Doves	1,075	14,753
Chukars	247	582
Sage Grouse	119	160
Forest Grouse	132	132
Quail	138	237
Total	6,337	28,070

Other wildlife species furnishing limited hunting opportunities include antelope, waterfowl, and beaver. About 25 antelope are killed each year and 50 beaver harvested. Data on waterfowl was not compiled but harvest is also low.

CHAPTER V

ECONOMIC DEVELOPMENT

This chapter shows economic development including past growth, current conditions, trends, and projections in agriculture, population, employment, income, and recreation.

PAST AND PRESENT CONDITIONS

Economic development began with Mormon settlement of the area in 1849 and rapidly grew in population to near current levels. Economic growth has been constant through history but has lagged behind state and national growth rates.

HISTORICAL DEVELOPMENT

The first white men to visit the Beaver River Basin were Fathers Escalante and Dominquez in 1776. They were looking for a route to California and investigating the existence of a "salt water lake." Fur trading and trapping followed, in 1826, when Jedediah Smith and others came to the area.

In 1849, Brigham Young sent an expedition from Salt Lake City to explore the southern Utah area to determine locations for settlement between the Salt Lake Valley and what is now Arizona. The announced goal was to "establish a chain of forts from Salt Lake City to the Pacific Ocean." Over a three-month period, the expedition covered 800 miles, making detailed records on topography, available grazing, water, vegetation, timber supplies and favorable locations for settlements.

In the same year, a group was sent to settle Little Salt Lake Valley (Parowan). The following year settlements were made in Pavant Valley (Fillmore) and another in Little Salt Lake Valley (Cedar Fort or Cedar City). Parowan was settled by a group of 35 families containing 167 people who left Salt Lake City in December, 1849. In 1851 crops were harvested from 1,000 acres of land. 1/

1/ Leonard J. Arrinton, Great Basin Kingdom, University of Nebraska Press, 1966, p. 86.

In 1856, twenty men and their families left Parowan to settle Beaver. These settlers, mostly cattlemen, were interested in the Beaver Valley grazing lands. Water was diverted from the Beaver River and irrigated crops established. Three years later, Minersville, 17 miles west of Beaver, was established for the purpose of mining lead, zinc and silver deposits.

A railroad was completed in 1880 to facilitate the transportation of silver ore from the San Francisco Mountains to Salt Lake City for smelting. The railroad also established Milford as a transportation center for agricultural products. Later, the railroad was extended to Cedar City and California.

The colonization and development of the Beaver River Basin followed the traditional Mormom (military fashion) pattern. Settlement and development was a directed movement according to carefully worked out plans, rather than spontaneous and individual movements. Settlement companies were organized in groups of ten, fifty, and one hundred with appointed leaders. Upon reaching their destination, the colonists retained their organization. Development of the community was always on a cooperative basis. The first order of business was to build a fort. Next, organized groups started "public works" projects of digging irrigation canals, erecting fences, planting crops, and building roads and homes.

The distribution and use of the land and water resources was also on a controlled and systematic basis. The distribution of lands at Parowan is a good example. Acre lots within the community were surveyed and assigned numbers and distributed on a community drawing basis with each family receiving one lot. On these lots, families built their homes, planted gardens, and erected livestock sheds.

Outside of the village, irrigable lands were surveyed into 10 acre tracts of first and second class lands. Three drawings were held in all, with each family getting a city lot, 10 acres of first class land and 10 acres of second class land. Lands outside of city lots and irrigable tracts were treated as common property. Cattle were collected into herds and grazed together.1/ Early settlers in Utah soon recognized that irrigation was necessary for successful agricultural production and they adopted the principle that land and water resources were subject to public rather than private ownership. The Mormon policy was as follows:

1/ Ibid., pp. 89-95

"There shall be no private ownership of the streams that come out of the canyons, nor the timber that grows on the hills. These belong to the people; all the people." 1/

The decision of public ownership with respect to water set an important precedent. Anglo-Saxon law used in the East provided that water must not be taken from the streams unless returned in the same volume and it was obvious that the use of water for irrigation robbed a stream of part of its water supply. The Mormons worked out an arangement where dams and ditches were built on a community basis, rights to use the water were associated with the utilization of the land, and a public authority was appointed to supervise the appropriation and distribution of water. Their goal was equitable division and maximum use of the available water supplies.2/

When Utah became a territory, this system of public ownership was confirmed. The territorial government also provided for the creation of irrigation districts in 1865. According to Thomas, the vast majority of irrigation works in Utah, "were built by the farmers, owned by the farmers, and operated by the farmers. In fact, they constitute one of the greatest and most successful community and cooperative undertakings in the history of America." 3/

Natural disasters and hazards have been numerous over the years. Drought, insect infestation, floods, and severe winters have plagued the area. In 1855 and 1856, a drought and grasshopper infestation reduced agricultural production to the point that the people were in a position of semi-starvation.

The primary economic problem of Mormon Country in the 1870's and 1880's was overpopulation due to immigration flows and natural increase. History indicates that all the water was appropriated. Young married couples were unable to establish farms near home and older people were under-employed. At this point, the Church started projects to increase the supply of irrigable lands and supported the movement of people to adjacent states, Canada, and Mexico. The population and resource problems have continued and are evident in the economy today.

HUMAN RESOURCES

Human resources vary widely throughout the Basin from active growth in the Cedar City area to declining activity in other areas. Data from the U.S. Census of Population were used to establish

---

1/ *Ibid.*, p. 52.
2/ *Ibid.*, pp. 52-53
3/ Thomas, *Development of Institutions Under Irrigation*, p. 27.

trends in population, employment, and personal income. Economic activity is primarily related to agriculture, but mining, railroading, health and education services, and manufacturing are also important.

POPULATION

Cedar City is the only community in the area that has experienced consistent population increases over the last 30 years. Fillmore, Milford, Minersville and Paragonah all had the population increases from 1940 to 1950, but have declined since 1950. Populations of Beaver, Parowan, Meadow and Kanosh have all declined over the last 30 years (Table 6).

TABLE 6.--Population of selected incorporated and unincorporated places, Beaver River Basin

Place	County	Year 1940	1950	1960	1970
		---Number---			
Beaver	Beaver	1,808	1,685	1,548	1,453
Cedar City	Iron	4,695	6,106	7,543	8,946
Enterprise	Washington	619	790	859	844
Enoch	Iron	-	-	250	120
Fillmore	Millard	1,785	1,890	1,602	1,411
Kanosh	Millard	526	476	499	319
Minersville	Beaver	570	593	580	448
Meadow	Millard	422	378	244	238
Milford	Beaver	1,396	1,673	1,471	1,304
Paragonah	Iron	365	404	300	275
Parowan	Iron	1,525	1,455	1,486	1,423

Source: U.S. Census of Population

Population within the study area was stable between 1960 and 1970. A small decrease was recorded between 1950 and 1960, however, the Basin population had been decreasing prior to 1950. From 1900 to 1950 the population increased by 95 percent. The portion that the Basin population is of the State population has been decreasing since 1920. In 1920, the Basin population was 3.37 percent of the State and in 1970 it had decreased to 1.74 percent of the State population. From 1950 to 1970 the population in the Basin decreased by 2 percent while the State population increased by 54 percent.

Population trends by subbasins vary, the number of people in the Cedar-Parowan and Escalante Desert subbasins have been increasing

while populations in the Fillmore and Beaver-Milford subbasins has been decreasing (Table 7).

TABLE 7.--Population by subbasin, Beaver River Basin

	Year			
Subbasin	1940	1950	1960	1970
Fillmore[a]	3,618	3,533	2,628	2,193
Beaver-Milford	5,014	4,856	4,331	3,800
Cedar-Parowan	8,056	9,124	10,010	10,966
Escalante Desert	1,050	1,340	1,458	1,489
Basin Total[b]	17,738	18,853	18,427	18,448

a Does not include the Tintic Watershed
b County population figures were adjusted to reflect Beaver River Basin boundaries
Source: U.S. Census of Population

Beaver and Millard counties have a higher portion of their population represented in the over 45 age group and a smaller portion of their population in the under 45 age group when compared to Iron County and the State population. Iron County figures show a higher portion of young people in the under 24 age group than the State and other counties. This can partly be explained by the presence of the college at Cedar City. Median age levels are as follows: Beaver County, 29.1 years; Millard County, 27.8 years; Iron County, 22.5 years; and the State, 25.2 years.

When compared with the State, all the Basin counties have lower percentage of people in the 25-34 age group, and the Beaver and Millard Counties have a lower percentage in the 15-24 age group. These differences would indicate that the young people are leaving after finishing their education. The portion of the population in the over 65 age group in Beaver and Millard Counties is nearly double the figure in Iron County and the State.

EMPLOYMENT

Total employment in Beaver and Millard Counties remained about the same despite population decreases. This indicates that a larger portion of the population is joining the work force. All increased employment in the Basin was in Iron County.

Changes in the employment by sectors were not the same in all counties. Beaver and Millard had increased employment in the

mining category and Iron County decreased. All counties decreased in agricultural employment with the largest decrease in Millard County. Jobs in manufacturing, health services, and educational services increased in all counties (Table 8).

TABLE 8.--Employment by sector, Beaver River Basin

	Year			
	1940	1950	1960	1970
Agriculture and forestry	1,850	2,000	1,300	1,000
Mining	640	690	625	500
Manufacturing	50	100	140	475
Other	1,910	3,360	4,435	5,130
Total	4,450	6,150	6,500	7,000

Source: U.S. Census of Population

PERSONAL INCOME

Total personal income increased from $25.9 million in 1958 to $46.4 million in 1968 (Table 9). The trend has been for gradual increases in income from wage and salary disbursements, property income and transfer payments. Proprietors' income has varied from year to year resulting in total personal income varying instead of increasing gradually.

In 1960, wages and salaries accounted for 61 percent of the personal income in the area; proprietors' income, 19 percent; property income, 11 percent; and transfer payments, 8 percent. By 1968, wages and salaries accounted for 57 percent; proprietors' income, 17 percent; property income, 17 percent; and transfer payment, 9 percent.

During 1960, 2.07 percent of the State's population resided in the Basin and their personal income was only 1.83 percent of the State total. The 1960 per capita income was $245 less than State. By 1968, this figure had increased to $282.

TABLE 9.--Personal income by source, Beaver River Basin[a]

Item	1958	1960	1962	1964	1966	1968
	-----------------1,000 Dollars					
Personal income	25,856	30,675	33,916	34,968	39,711	46,392
Wage and salary disbursements	17,111	18,750	19,732	20,750	22,759	26,488
Other labor income	570	687	780	887	988	1,153
Proprietors' income	3,720	5,882	7,004	5,621	7,122	7,987
Farm	753	2,793	3,484	3,160	4,495	5,176
Nonfarm	2,967	3,089	3,520	2,461	2,627	2,811
Property income	2,853	3,507	4,302	5,828	6,664	7,825
Transfer payments	2,255	2,540	2,894	2,706	3,260	4,336
Less: Contributions for Social Insurance	653	691	796	824	1,082	1,397

a Individual county data adjusted to reflect Beaver River Basin boundaries

Source: Hanks, J. Whitney, Personal Income in Utah Counties, 1958-1969, Center for Economic and Community Development, Bureau of Economic and Business Research, University of Utah, March, 1970

AGRICULTURE ECONOMY

Data from the U.S. Census of Agriculture were used to establish trends within agriculture over the 1949-1964 period. In cases where only a portion of the county was in the Basin, county census figures were adjusted to reflect the Basin area. It was assumed that county census data were representative of the portion of the county in the Basin.

FARMS

From 1949 to 1964, the number of farms decreased 367 or 30 percent. Also, the average size of farms has been increasing. This consolidation is expected to continue. Land in farms increased considerably during the 1949-1954 period but has been relatively stable since 1954 (Table 10).

TABLE 10.--Number, total acreage, and average size of farms, Beaver River Basin

	Unit	1949	1954	1959	1964
Farms	Number	1,257	1,207	1,037	890
Land in farms	Acre	862,224	1,028,650	1,155,523	1,053,223
Average size of farm	Acre	685.9	852.2	1,114.3	1,184.0

Source: U.S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

The number of irrigated farms has decreased from 1,021 in 1949 to 704 in 1964. Farms with no irrigated land varied from 236 in 1949 to 186 in 1964. In 1949, there were 654,300 acres of land in irrigated farms and by 1964 this acreage increased to 784,900 acres. The average size of irrigated farms increased from 641 acres in 1949 to 1,115 acres by 1964.

CROP PRODUCTION

The trend in area of irrigated land has been toward increased irrigated acreage, except in 1959 when the acreage went down, but it again increased in 1964 (Table 11). The acreage of irrigated cropland harvested has generally followed the trend of irrigated land. The total cropland harvested has been influenced by agricultural programs and has varied over the years.

TABLE 11.--Irrigated land in farms, irrigated cropland harvested and total cropland harvested, Beaver River Basin

Item	1949	1954	1959	1964
	Acres			
Irrigated land in farms	77,820	78,700	75,500	80,100
Irrigated cropland harvested	65,973	66,000	58,800	63,700
Total cropland harvested	93,658	91,200	74,000	77,800

Source: U.S. Census of Agriculture. Data adjusted to reflect Basin boundaries

Total crop production has been increasing. Data indicates a trend toward increased forage (hay, pasture and silage) production, however, the acreage of pasture and silage decreased in 1964 while hay production increased. The production of grain crops decreased during the 1949-1964 period. The acreage and production of potatoes and sugar beets have varied from year to year. Per acre yields of these crops have also varied from year to year. The yield per acre of alfalfa hay, barley, and spring wheat increased during the 1949-1964 period.

TABLE 12.--Average crop yields per harvested acre, Beaver River Basin

Crop	Unit	Census Year 1949	1954	1959	1964
Alfalfa hay[a]	Ton	2.2	2.3	2.6	3.0
Other tame hay	Ton	-	-	1.5	2.0
Native hay	Ton	-	-	1.2	1.7
Alfalfa seed	Cwt.	2.3	2.2	2.6	1.5
Barley	Bushel	39	45	48	56
Wheat (winter)	Bushel	16	15	16	18
Wheat (spring)	Bushel	29	36	37	43
Oats	Bushel	47	43	43	42
Potatoes	Cwt.	204	226	201	171
Sugar beets	Ton	10	12	13	8
Corn silage	Ton	9	11	14	14

a Alfalfa hay production for 1949 and 1954 are all hay figures and represent all crops cut for hay in those years.
Source: U.S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

TABLE 13.--Total production of crops, Beaver River Basin

Crop	Unit (1,000)	Census Year 1949	1954	1959	1964
Alfalfa hay[a]	Tons	78.4	101.0	95.8	121.4
Other tame hay	Tons	-	-	3.6	6.0
Native hay	Tons	-	-	3.1	5.3
Alfalfa seed	Cwt.	19.4	20.0	16.7	13.2
Barley	Bushels	446.7	427.2	443.9	415.7
Wheat (winter)	Bushels	435.6	330.4	145.0	127.6
Wheat (spring)	Bushels	66.4	84.1	56.0	28.4
Oats	Bushels	100.1	73.9	27.5	41.7
Potatoes	Cwt.	523.1	621.0	443.5	547.2
Sugar beets	Tons	2.1	5.3	1.1	6.5
Corn silage	Tons	23.0	26.6	39.5	33.0

a Alfalfa hay production for 1949 and 1954 are all hay figures and represent all crops cut for hay in those years.
Source: U.S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

LIVESTOCK PRODUCTION

Numbers of livestock varied over the 1949-1964 period. Cattle and calves increased in numbers from 1949 to 1954, decreased from 1954 to 1959 and again increased from 1959 to 1964. Sheep and lamb numbers increased from 1949 until 1954 and decreased since that time. Hogs and pigs have had an up-and-down pattern. Milk cows and turkeys have consistently decreased in number over the period. Turkey production had discontinued by 1964 (Table 14).

TABLE 14.--Livestock on farms, Beaver River Basin

Type of livestock	Year 1949	1954	1959	1964
	Number			
Cattle and calves	43,991	59,725	56,237	61,904
Milk cows	4,921	4,963	4,627	3,646
Sheep and lambs	85,553	118,401	106,513	93,048
Hogs and pigs	6,355	4,342	5,972	3,153
Turkeys	63,223	47,857	2,578	230

Source: U.S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

The number of cattle and calves sold from farms increased until 1959 and then decreased by 1964. A comparison of cattle inventories and sales indicate 1959 was an inventory reduction year and 1964 was an inventory building year. A similar comparison for sheep indicates an inventory reduction started in 1959 and continued in 1964. Butterfat production has consistently decreased over the 1949-1964 period, while whole milk production increased until 1959 and then decreased in 1964 (Table 15).

TABLE 15.--Livestock and livestock products sold, Beaver River Basin

Product	Unit	Year 1949	1954	1959	1964
Cattle and calves	Number	17,802	21,195	37,638	31,298
Butterfat	Pounds	41,039	28,188	11,675	8,510
Whole milk	1,000 Pounds	18,724	28,099	32,308	30,970
Sheep and lambs	Number	60,830	72,529	91,456	59,995
Wool shorn	1,000 Pounds	643.6	846.9	835.0	715.1
Hogs and pigs	Number	12,414	3,537	5,515	3,816

Source: U.S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

VALUE OF FARM PRODUCTS

Total value of farm products sold increased from $8.8 million in 1949 and 1954 to $12.2 million in 1959 and then decreased to $10.9 million in 1964 (Table 16). In 1949 and 1964, the Basin produced 6.8 percent of the State total of agricultural products. The value of farm production has remained stable in comparison to the State.

TABLE 16.--Value of farm products sold, Beaver River Basin

Product	Year 1949	1954	1959	1964
	1,000 Dollars			
Crops sold	3,294.4	3,374.8	2,777.3	3,855.4
Field crops	3,248.6	3,353.0	2,759.3	3,839.9
Vegetables	39.0	14.7	.7	.8
Fruits and nuts	6.0	4.1	3.6	3.0
Horticultural	.8	3.0	13.7	11.7
Livestock and livestock products	5,538.9	5,389.0	9,409.1	7,000.7
Dairy products	764.8	949.6	1,153.2	1,107.3
Poultry and poultry products	731.0	466.4	173.4	376.0
Livestock	4,043.1	3,973.0	8,082.5	5,517.4
Total value of sales	8,833.3	8,763.8	12,186.4	10,856.1

Source: U.S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

E C O N O M I C   P R O J E C T I O N S

Economic development of the Beaver River Basin, including population, employment, income, recreation, and agricultural activities, are projected to the years 1980, 2000, and 2020. These projections are intended to represent economic activities which are an extension of historical trends.

PROCEDURES

The designation "OBERS" projections has reference to a set of economic projections issued by the Office of Business Economics, U.S. Department of Commerce and the Economic Research Service, U.S. Department of Agriculture. The Office of Business Economics prepared projections on population, employment, personal income and

earnings. Economic Research Service provided projections on needs for agricultural commodities. Projections were prepared for water resource regions and subregions within the United States. The National projections provide an overall economic base for use in water and related land resource planning. In this study, these projections serve the following purposes: (1) provide data needed to establish past and current relationships between water use and economic activity; (2) provide a framework to identify economic strengths and weaknesses; (3) furnish an analytical base from which to prepare projections; and (4) provide a base from which economic consequences of alternative plans could be measured.

Projections of economic activity are not predictions of future levels of production, but are approximations of what would occur if a given set of assumptions are met. Future agricultural production in the United States was determined by projecting future national requirements for commodities based on assumed population growth, gross national product, per capita income, consumer preferences, and agricultural imports and exports. The National projections for the Sevier Lake Subregion were disaggregated to the Beaver River Basin. These baseline projections should not be viewed as a quota of production, but rather as a level of economic activity associated with an extension of an historical trend.

POPULATION

The area population is projected to remain at about the present level until 1980 and then increase after that period (Table 17). The number of people in the Cedar-Parowan subbasin is expected to increase in the future, while the population in the Fillmore and Beaver-Milford subbasins are projected to decrease. Population increases in Escalante Desert area have been related to ground water developments. Restraints have now been placed on ground water pumping which have limited agricultural activities and will effect future growth.

TABLE 17.--Projected population by subbasins, Beaver River Basin

Subbasin	Year			
	1965 (base)	1980	2000	2020
	Number			
Fillmore	2,400	1,700	1,600	1,500
Beaver-Milford	4,065	3,400	3,200	3,000
Cedar-Parowan	10,500	12,000	14,500	17,500
Escalante Desert	1,470	1,400	1,200	1,000
Basin	18,435	18,500	20,500	23,000

EMPLOYMENT

Employment is projected to increase from 6,750 in 1965 to 9,200 in 2020. Employment as a percentage of population was projected using historical trends established during the 1940-1964 period. In 1965, this was 36.5 percent and is projected to increase to 38.0 percent, 39.0 percent and 40.0 percent by 1980, 2000, and 2020, respectively.

TABLE 18.--Projected employment by sector, Beaver River Basin

Sector	Year 1965 (base)	1980	2000	2020
	Number			
Agriculture & forestry	1,150	800	725	575
Mining	550	500	460	425
Manufacturing	300	600	940	1,500
Other	4,750	5,300	5,875	6,700
Total	6,750	7,030	8,000	9,200

Long-term employment projections vary significantly by sector. Employment in the service and manufacturing sectors is projected to increase while the agriculture and mining sectors are projected to decrease. Future changes in both the structure and productivity within agriculture will reduce the number of people employed. The agricultural work force is projected to decrease from 17 percent of the total employment in 1965 to 6.3 percent by 2020. Mining employment also will be affected by expected productivity advances.

PERSONAL INCOME

Projected values for personal income provide a broad framework for measuring future economic expansion. Personal income, per capita income and earnings per worker are projected to increase as shown in Table 19. When compared to the United States averages, the Basin shows the following projected per capita income deficits: 1965, $555; 1980, $1,405; 2000, $2,418; and 2020, $3,122. Projections of personal income are tied to national projections. The projections used, therefore, reflect both the national and area trends.

TABLE 19.--Projected personal income, per capita income and earnings per worker, Beaver River Basin

Item	Unit	Year			
		1965 (base)	1980	2000	2020
Personal income	Dollars	37,812	51,985	100,901	220,800
Per capita income	Dollars	2,051	2,810	4,922	9,600
Earnings per worker	Dollars	4,780	6,013	9,992	19,488

AGRICULTURAL PRODUCTION

The baseline projections for crop production, livestock, and livestock products are based on census date and projected to future time frames based on OBERS methodology. The alternative crop production projections (page 71) are based on field survey data using the same methodology.

FOOD AND FIBER

Projections reflect the average level of management and inputs. The total production projections reflect expected future use of inputs, such as water, fertilizer, insecticide, herbicides, cultural practices and the adoption of new plant varieties (Table 20).

Feed grain production is projected to increase from 441,000 bushels in 1965 to 834,700 bushels in 2020. Wheat production during the same is expected to increase 156,100 bushels to 251,000 bushels. Grain production includes the use of both irrigated and non-irrigated land.

Hay and forage production is expected to increase. Hay and corn silage are projected to increase by 38 percent from 1965 to 2020; pasture by 47 percent and range forage by 42 percent, during the same period. Alfalfa seed production was projected to increase at the same rate as alfalfa hay production. Sugar beet production is projected to increase for the target years. Potato production is projected to decrease from 1965 to 1980 and then increase from 1980 to 2020.

The production of livestock and livestock products are all projected to increase from 1965 to 2020. The percentage increases are as follows: beef and veal, 200 percent; pork, 25 percent; lamb and mutton, 79 percent; and whole milk, 111 percent. Pork production is the only commodity that is projected to decrease during any of the target years.

TABLE 20.--Projected agricultural production by commodity and product groups, Beaver River Basin

Commodity	Unit (1000)	Year 1965 (base)	1980	2000	2020
Feed Grains					
Oats	Bu.	42.0	44.1	52.1	58.0
Barley	Bu.	399.0	504.9	598.5	776.7
Hay and Forage					
Hay	Tons	129.5	136.2	160.6	178.7
Silage	Tons	33.6	35.3	41.6	46.4
Pasture	AUM	65.6	79.6	91.6	96.1
Range	AUM	272.6	287.4	352.6	386.7
Cash Crops					
Alfalfa Seed	Cwt.	13.5	14.2	16.8	18.6
Wheat	Bu.	156.1	192.9	217.6	251.0
Sugar Beets	Tons	8.0	16.8	26.1	37.9
Potatoes	Cwt.	560.0	500.1	658.5	863.1
Meat Animals[a]					
Beef and Veal	lbs.	15,385	26,343	35,072	46,022
Pork	lbs.	1,395	1,027	1,343	1,737
Lamb & Mutton	lbs.	5,538	5,692	7,545	9,892
Dairy Products	lbs.	32,100	40,197	52,365	67,600

[a]Liveweight basis

CROP YIELDS

Projected crop yields are needed to determine land and water resource use pattern necessary to achieve projected agricultural production. Productivity represents what could be expected with average management and available resources. Basic assumptions used in yield projections include available effective pesticides and herbicides and increased fertilizer use.

Projected yield increases vary by individual crops. Large yield increases are projected for grain crops, medium increases for potatoes and corn silage, and smaller increases for forage crops and sugar beets (Table 21).

TABLE 21.--Projected average crop yield per harvested acre, Beaver River Basin

Crop	Unit	Year			
		1965 (base)[a]	1980	2000	2020
Irrigated Crops					
Alfalfa hay	Ton	3.0	3.4	3.8	4.2
Other tame hay	Ton	2.0	2.2	2.5	2.8
Native hay	Ton	1.7	1.9	2.1	2.4
Pasture	AUM	4.0	4.5	4.8	4.8
Alfalfa seed	Cwt.	1.5	1.7	1.9	2.1
Corn silage	Ton	14.0	16.1	19.3	22.0
Barley	Bu.	56.0	64.0	83.0	95.0
Wheat	Bu.	43.0	66.0	80.0	88.0
Oats	Bu.	42.0	48.0	63.0	71.0
Potatoes	Cwt.	175.0	200.0	240.0	273.0
Sugar beets	Ton	10.0	11.0	12.2	13.4
Non-irrigated Crops					
Wheat	Bu.	18.0	20.5	24.0	26.0
Barley	Bu.	35.0	40.0	45.0	50.0

[a]Similar to yields reported in the 1964 Agricultural Census

LAND USE

Harvested acreage required to produce the quantity of crops using OBERS projections are shown in Table 22. Idle or unused land is not included. Considerable acreages of cropland and rangeland are idle periodically. The projections do reflect some double cropping. It was assumed that one-half of the alfalfa seed was produced on acreages where a first cutting of alfalfa was taken. Aftermath grazing was included on all croplands.

The acreage of harvested cropland and irrigated pasture land required to produce OBERS production allocations show that total land requirements will decrease in 1980 and 2000. The 2020 requirements indicate that 3,000 additional acres, above the 1965 base year acreage, will be needed. Sugar beet and pasture acreages are the only categories that show consistent increases needed over the projection period.

Water consumptive use requirements to meet projected crop production would parallel irrigated cropland requirements. Irrigation water requirements would decrease in the 1980 and increase in the 2000 and 2020 target years.

TABLE 22.--Projected cropland harvested at OBERS level of production, Beaver River Basin

Item	Year			
	1965 (base)[a]	1980	2000	2020
	------------1,000 Acres------------			
Irrigated Land				
Alfalfa hay[b]	41.0	38.6	40.8	41.1
Other tame hay	3.0	2.0	2.0	2.0
Native hay	.3	.3	.3	.3
Alfalfa seed[b]	9.0	8.4	8.8	8.9
Corn silage	2.4	2.2	2.2	2.1
Feed grains	7.5	6.0	4.6	6.8
Wheat	.7	-	-	-
Sugar beets	.8	1.5	2.1	2.8
Potatoes	3.2	2.5	2.9	3.2
All other	.3	.3	.3	.3
Irrigated cropland harvested	63.7	57.6	59.6	63.1
Permanent pasture	6.0	6.0	6.0	6.0
Other pasutre	10.4	11.7	13.1	14.0
Total irrigated land	80.1	75.3	78.7	83.1
Dryland Harvested				
Wheat	7.0	9.4	9.1	9.7
Barley	1.0	4.5	4.8	4.2
Other	5.9	-	-	-
Total dryland harvested	13.9	13.9	13.9	13.9

[a]Similar to harvested acreage reported in the 1964 Agriculture Census

[b]Alfalfa seed acreage reflects the total acreage used to produce seed. In practice only half is used for seed and half for alfalfa hay and seed.

LIVESTOCK PRODUCTION

Farmers have been successful in increasing total production. Both crop yields and livestock production per unit of input have been increasing. Total digestible nutrients required per unit of output produced is projected to decrease in all feed categories. Components of the various livestock rations are projected to change as grain and protein supplements replace some hay and forage.

Total feed requirements are projected to increase for livestock based within the Basin (Table 23). Not included are feed requirements for livestock based outside the Basin but brought in for part of the year for feeding purposes. Percentage increases from the 1965 base year to 2020 by categories is as follows: range forage, 57 percent; hay, 54 percent; pasture, 230 percent; corn silage, 192 percent; and protein supplements, 79 percent.

TABLE 23.--Projected feed requirements for livestock, Beaver River Basin

Type of feed	Unit	Year 1965 (base)	1980	2000	2020
Range forage[a]	AUM	276,322	322,815	380,147	434,594
Hay and pasture (Hay equivalent)	Ton	92,429	112,526	123,366	142,211
Feed grain	Bu.	922,310	1,618,859	2,302,064	3,043,495
Corn silage	Ton	32,466	52,343	74,544	94,690
Protein supplement	Cwt.	131,624	183,018	188,967	235,854

[a]For livestock based within the Basin

Surplus or deficit of projected feed production compared to livestock requirements are shown in Table 24. In 1965, the Basin produced a surplus of hay but had a deficit in feed grains. The range resources were essentially in balance. Projections indicate that hay will continue to be surplus but there will be deficits in range forage as well as corn silage and feed grains.

TABLE 24.--Projected surplus (+) or deficit (-) of feed to meet livestock requirements, Beaver River Basin

Type of feed	Unit	Year 1965 (base)	1980	2000	2020
Range forage[a]	AUM	-4,122	-35,415	-27,547	-47,894
Hay and pasture (Hay equivalent)	Ton	+59,384	+50,748	+68,390	+69,176
Feed grain	Bu.	-403,260	-973,409	-1,532,664	-2,083,295
Corn silage	Ton	+1,134	-17,043	-32,944	-48,290

[a]Available to livestock based within the Basin

The land use changes necessary to bring crop production and livestock enterprises into balance are shown in Table 25. To produce all the livestock feed requirements in the Basin would require an increase in irrigated land use.

TABLE 25.--Projected land use change necessary to bring crop production and livestock feed needs into balance, Beaver River Basin

Type of Feed	Year 1965 (base)	1980	2000	2020
	--------Acre--------			
Range forage	+41,220	+354,150	+275,470	+478,940
Hay and pasture (Hay equivalent)	-19,794	-14,926	-17,997	-16,470
Feed grain	+72,010	+152,095	+184,658	+219,294
Corn silage	-81	+1,059	+1,707	+2,195
Total (irrigated land)	+52,135	+138,228	+168,368	+205,019

There are enough arable lands within the Basin to produce livestock feed requirements, but there is not enough irrigation water available. Present water use in the water budget areas is in excess of the supply. Ground-water reservoirs presently used for irrigation are being mined to support the agricultural economy.

ALTERNATIVE CROP PROJECTIONS

Alternative crop projections are based on land use and farm enterprise surveys conducted to determine the agricultural base and gather information on farm inputs and outputs. The OBERS baseline projections were developed using agricultural census data. Considerable difference existed between the agricultural base and crop yields reported in the census, and figures established in the surveys. Livestock numbers and production rates used in OBERS baseline projections were also used in the alternative projections. The same basic assumptions on management, inputs and technological changes were assumed for both sets of projections, only the base year acreages and crop yields were different. Projections on crop production, crop yields and crop acreages are shown in Tables 26, 27, and 28. These data represent the agricultural base used in evaluating the present and potential opportunities.

TABLE 26.--Projected cropland harvested, Beaver River Basin

Item	1965[a] (base)	1980	2000	2020
	-----	-----	1,000 Acres	-----
Irrigated Land				
Alfalfa hay[b]	51.4	47.1	49.8	50.2
Other tame hay	1.0	1.0	1.0	1.0
Native hay	.3	.3	.3	.3
Alfalfa seed[b]	10.0	9.1	9.6	9.8
Corn silage	3.7	3.4	3.3	3.3
Feed grains	19.1	20.7	19.0	21.3
Wheat	1.2	-	-	-
Potatoes	6.0	4.7	5.1	5.9
All other	.3	.3	.3	.3
Cropland harvested	88.0	82.1	83.6	87.2
Permanent pasture	3.8	3.8	3.8	3.8
Other pasture	6.4	7.2	8.1	8.6
Total irrigated land	98.2	93.1	95.5	99.6
Dryland Harvested				
Wheat	7.0	13.0	12.5	13.4
Barley	1.6	-	-	-
Pasture	15.5	30.7	30.7	30.7
Total dryland harvested	24.1	43.7	43.2	44.1

[a]Crop acreage and crop distribution shown for 1965 are those identified by a land use survey conducted by Soil Conservation Service.

[b]Alfalfa seed acreage reflects the acreage used to produce seed. In practice only half is used for seed and half for first crop alfalfa hay and second crop alfalfa seed.

TABLE 27.--Projected average crop yield per harvested acre, Beaver River Basin

Crop	Unit	1965[a] (base)	1980	2000	2020
Irrigated Crops					
Alfalfa hay	Ton	3.8	4.3	4.8	5.3
Other tame hay	Ton	2.0	2.2	2.5	2.8
Native hay	Ton	1.7	1.9	2.1	2.4
Pasture	AUM	6.0	6.8	7.2	7.2
Alfalfa seed	Cwt.	2.0	2.3	2.5	2.8
Corn silage	Ton	18.6	21.4	25.6	29.2
Barley	Bu.	75.0	86.0	111.0	127.0
Wheat	Bu.	72.0	82.0	106.0	122.0
Potatoes	Cwt.	180.0	206.0	247.0	280.0
Non-irrigated Crops					
Barley	Bu.	35.0	40.0	45.0	50.0
Wheat	Bu.	18.0	20.5	24.0	26.0
Pasture	AUM	1.0	1.2	1.35	1.5

[a]Base year yields are average yields reported by farmers in 1967 farm survey conducted by Economic Research Service

TABLE 28.--Projected agricultural production by commodity and product groups, Beaver River Basin

Commodity	Unit (1,000)	1965[a] (base)	1980	2000	2020
Feed Grains					
Oats	Bu.	143.0	150.2	177.3	197.3
Barley	Bu.	1,289.5	1,631.2	1,934.3	2,509.4
Hay and Forage					
Hay	Ton	195.3	205.3	242.2	269.3
Silage	Ton	68.8	72.2	85.2	94.9
Pasture	AUM	76.7	93.0	107.1	112.3
Range	AUM	393.4	414.6	508.7	557.8
Cash Crops					
Alfalfa seed	Cwt.	20.0	21.0	24.9	27.5
Wheat	Bu.	216.0	266.8	200.9	247.1
Potatoes	Cwt.	1,080.0	964.4	1,269.0	1,664.3

[a]Based on field surveys

The surplus or deficit of projected livestock feed production compared to livestock feed requirements are shown in Table 29. In the 1965 base year, a surplus was produced in all feed categories. This same condition is projected to exist in 1980. By 2000, feed grains needed to support the livestock economy would be in short supply. During these same periods, all other available livestock feeds would continue to exceed livestock requirements.

TABLE 29.--Projected surplus (+) or deficit (-) of feed to meet livestock requirements, Beaver River Basin

Type of Feed	Unit	Year: 1965 (base)	1980	2000	2020
Range forage	AUM	+117,078	+91,785	+128,553	+123,206
Hay and pasture (Hay equivalent)	Ton	+129,000	+124,400	+155,200	+165,200
Feed grain	Bu.	+623,000	+295,900	-40,000	-163,200
Corn silage	Ton	+36,334	+19,857	+10,656	+210

The land use changes necessary to bring crop production and livestock enterprises into balance are shown in Table 30. A decrease in crop acreage would be required to establish a balance between crop production and livestock feed requirements. An increase in livestock production above projected demand would be necessary in order to use available feed, or feed export must continue if the present crop acreage is maintained.

TABLE 30.--Projected land use changes necessary to bring crop production and livestock feed requirements into balance, Beaver River Basin

Type of Feed	Unit	Year: 1965 (base)	1980	2000	2020
Range forage	Acre	-1,252,700	-927,000	-1,067,000	-924,000
Hay and pasture (Hay equivalent)	Acre	-34,000	-28,900	-32,300	-31,200
Feed grain	Acre	-8,300	-3,400	+3,600	+12,900
Corn silage	Acre	-2,000	-900	-400	-
Total (irrigated land)	Acre	-44,300	-33,200	-29,100	-18,300

IMPACTS OF RESOURCE USE CHANGES

An analysis was used to determine the effects of changes in irrigation water supplies by simulating the relationships of available root-zone water to net income associated with crop production. This analysis has three basic components: (1) determination of individual and area crop moisture needs, (2) allocation of available irrigation water to meet the needs, and (3) specification of net crop income associated with a given level of available soil moisture.

A "with-without" approach was used in evaluating changes that affect the availability of crop root-zone moisture. A 1956-1965 base period was used in identifying present conditions and for projecting future conditions.

AREA CROP INCOME WITHOUT DEVELOPMENT

Increased crop yields, larger farms, larger farm machinery, reduced labor inputs, increased fertilizer use, and continuation of going program improvements were projected without accelerated program improvements (Table 31). Crop rotation was held the same except the years of alfalfa in the rotation was reduced one year in 1980 and two years in 2020. Basin net crop income was determined for each year in the 1956-1965 base period and for each of the projected years.

The average annual net crop income with soil moisture deficits, potential net crop income without water shortages, and estimated average annual soil moisture deficts for the 1965, 1980, and 2020 base periods are illustrated in Figure 8.

VALUE OF WATER

The value of water has been estimated by simulating the consumptive use of root-zone water on irrigated cropland and net crop income over a series of 10 years (base period) and projected using the same procedure. These relationships were estimated for 1965, 1980, 2000, and 2020.

The average value of root-zone water consumptively used on irrigated cropland for the selected time periods is shown in Table 32. The average value of increased consumptive use of root-zone water in the Basin was $24.80 per acre-foot in 1965 and is projected to be $32.00 in 1980, $40.60 in 2000, and $50.20 in 2020. The value of increased consumptive use of root-zone water on irrigated croplands varies considerably between subbasins.

TABLE 31.--Projected net crop income without water resource development, Beaver River Basin[a]

Base Period year	Subbasin												Basin Total		
	Fillmore			Beaver-Milford			Cedar-Parowan			Escalante Desert					
	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020
	---1,000 Dollars---														
1	-425	-335	219	-319	14	717	-331	-172	320	-509	76	1,021	-1,584	-417	2,277
2	83	300	1,167	365	585	1,179	-35	237	820	-150	451	1,765	263	1,573	4,931
3	-175	37	742	420	566	1,142	-122	73	704	-334	173	1,496	-211	849	4,084
4	-321	160	433	-130	268	1,012	-485	-323	-3	-397	131	1,341	-1,333	-84	2,783
5	-177	6	633	-121	148	1,069	-501	-423	-63	-329	249	1,570	-1,128	-20	3,209
6	-211	-47	508	-83	295	1,037	-369	-170	168	-355	294	1,559	-1,018	372	3,272
7	-13	182	951	269	550	1,168	-81	112	645	-92	493	1,950	83	1,337	4,714
8	-263	-2	687	-11	438	1,132	-343	-86	292	-384	271	1,609	-974	621	3,720
9	155	448	1,393	241	536	1,217	-138	102	756	-105	488	1,734	153	1,574	5,100
10	232	575	1,380	266	566	1,234	186	398	1,029	-114	498	1,743	570	2,037	5,386
Average	-109	100	811	90	397	1,091	-222	-25	467	-277	312	1,579	-518	784	3,948
Potential	490	730	1,411	475	585	1,234	300	470	1,160	125	594	1,970	1,390	2,379	5,775

[a]Net crop income changes attributed to continuation of going program and technology changes

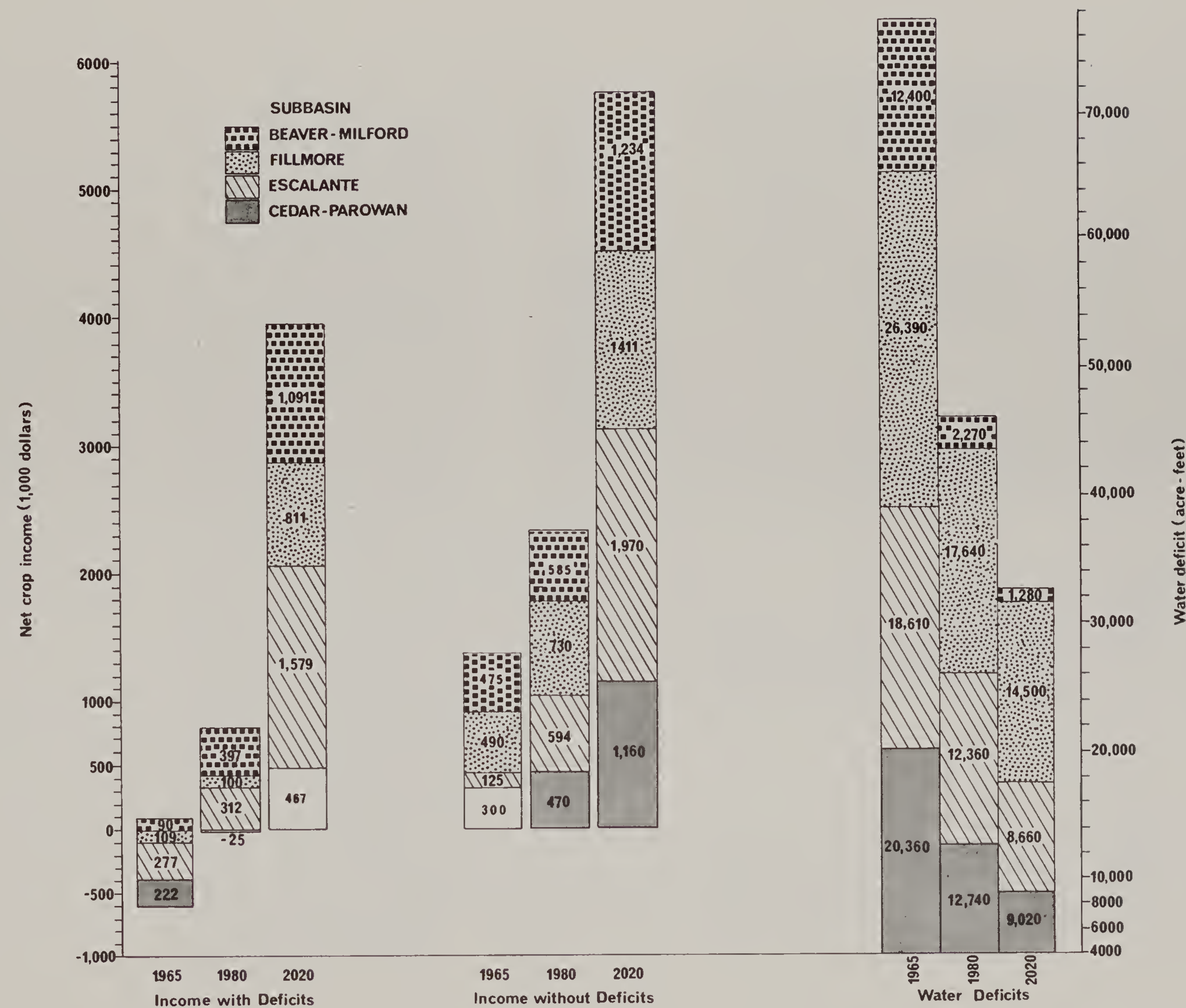


Figure 8: Present and projected water deficits and net crop income with and without water deficits. Beaver River Basin. (based on irrigation (ADP) program analysis).

TABLE 32.--Average value of root-zone water consumptively used on irrigated cropland, Beaver River Basin

Subbasin	Year 1965 (base)	1980	2000	2020
	---------------	Dollars/Ac. Ft.	---------------	
Fillmore	23.00	31.50	39.25	45.75
Beaver-Milford	28.00	38.60	46.80	58.60
Cedar-Parowan	25.80	33.30	42.50	51.00
Escalante Desert	24.20	26.70	36.00	49.50
Basin Average	24.80	32.00	40.60	50.20

RECREATION

The procedure used to project recreation demand is similar to that developed by the Bureau of Outdoor Recreation. Demand was established by three categories; population zone, socioeconomic factors, and opportunity factors.

Basin-wide present and projected recreation demand by activity is shown in Table 33. In 1965, 32 percent of the recreational activities were associated with hunting and fishing. By 1980, this demand is projected to decrease to 25.6 percent of the total and to 15 percent by 2020. In contrast, hiking and bicycling comprised only 2.5 percent of the total recreational time in 1965 and is projected to increase to 3.9 percent by 1980 and 7.4 percent by 2020. Camping activities are projected to comprise about 18 percent of the total demand by 1980 and 20 percent by 2020. Driving is expected to remain the most popular activity through the projection period.

TABLE 33.--Projected outdoor recreation demand, Beaver River Basin

Activity	Year 1965 (base)	1980	2020
	Visitor-days		
Driving	106,080	209,060	476,500
Picnicking	20,400	29,870	50,060
Fishing	61,200	101,600	133,500
Hunting	69,360	89,600	116,810
Swimming	8,160	14,930	33,370
Bicycling	2,080	7,300	40,250
Hiking	8,160	22,400	83,430
Boating	4,080	7,470	16,690
Golfing	12,240	32,260	150,180
Water skiing	400	800	2,400
Snow skiing	20,400	45,280	133,500
Horseback riding	16,840	37,330	66,750
Camping	73,440	133,810	331,910
Other	8,160	14,930	33,370
Total	408,000	746,640	1,668,720

CHAPTER VI

RESOURCE RELATED PROBLEMS AND NEEDS

This chapter describes resource related problems and needs. Overriding concerns relate to problems of a depressed economy and changing environment and the need to stabilize and enhance the resource base.

There has been a continual decline in population associated with the agricultural sector. Personal per capita income is below the state and national average and varies from year to year. A stable economy is needed through more diverse income producing enterprises. There is a need to reduce and if possible, reverse the declining rural population by stabilizing the agricultural economy.

Much can be accomplished by defining the resource problems and needs so planning can accommodate solutions. Damages from erosion, sedimentation, and flooding are problems over most of the Basin. Irrigation water supply variations, inefficient delivery and use, and related drainage are problems in the cropland areas.

There is a need for watershed protection, for flood prevention and sediment reduction. There are water conservation and salvage opportunities to reduce shortages and alleviate drainage problems. Needs for proper land use and management are becoming more critical, especially where livestock grazing, wildlife habitat, recreation, and environmental quality are concerned.

EROSION AND SEDIMENTATION

Four aspects of this problem are described: gross erosion, stream channel erosion, sediment yield from critical areas, and sediment deposition. Gross erosion evaluates the onsite loss of soil due to wind and water action and is expressed in inches of soil lost annually. Stream channel erosion is based on the miles of perennial stream that are stable, moderately eroding, or rapidly eroding within selected watersheds. Sediment yield from critical areas is based upon hydrologic and physical characteristics

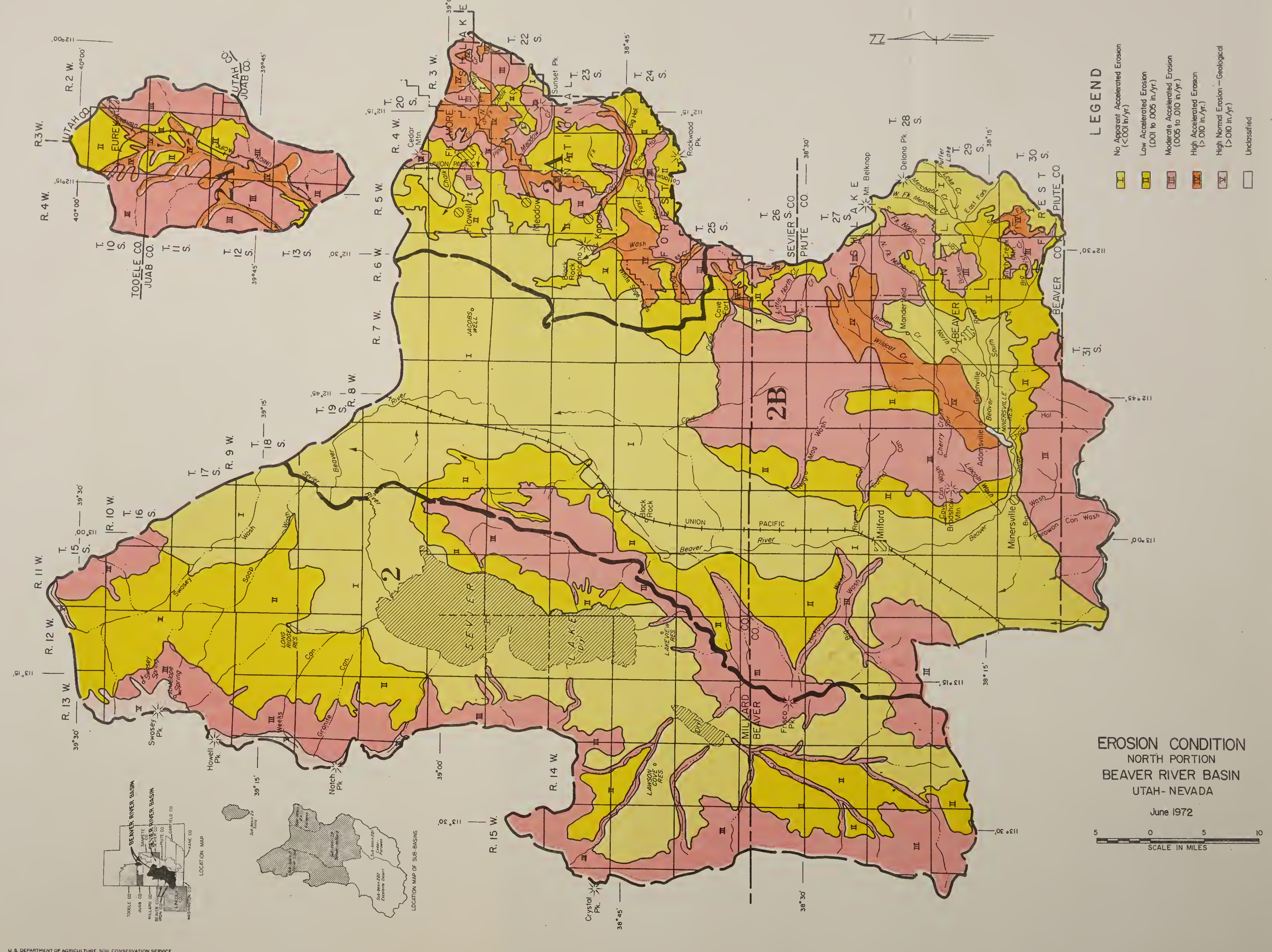
of each watershed and is expressed in acre-feet annually. Damages to fish habitat, reservoirs, irrigation systems, and other facilities are described in the sediment deposition section.

Solutions to erosion and sedimentation problems are needed to maintain the productivity of the land and to reduce downstream damages. There are 172,710 acres of primary critical area where erosion is taking place at a rate greater than .010 inches per year that need stabilization. In addition, there are roads and trails and disturbed areas due to mining, grazing, and fire where erosion rates should be reduced. Stream channel and gully erosion are a primary source of sediment and lead to stabilization needs for these portions of a drainage system. Structural measures such as reservoirs above croplands and irrigation diversion structures need to be installed with sediment storage and handling an integral part of their design.

GROSS EROSION

Mountains have been eroding at normal or geologic rates according to the particular combination of rock, physiography, climate, soil, and biota that characterize the basin. In areas of low rainfall, sparse plant cover provides little protection to the soil and violent thunderstorms frequently produce flash floods. A large part of the erosion in these areas is geologic or normal. In areas of higher rainfall, erosion is more often a direct result of man's activity.

The area was mapped according to rates and types of erosion. Erosion condition classes are indicated on the map following page 82, and the acreage of each class is shown in Table 34. Class V includes rates of high normal or geologic erosion exceeding .010 inches of soil loss per year. Class IV includes rates of high accelerated erosion of more than .010 inches per year. Class III includes moderate accelerated erosion of .005-.010 inches per year. Class II includes low accelerated erosion rates of .001-.005 inches per year, and Class I includes no apparent accelerated erosion or rates less than .001 inches per year.



EROSION CONDITION
NORTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA
June 1972
LEGEND
I No Apparent Accelerated Erosion (<.001 in./yr.)
II Low Accelerated Erosion (.001 to .005 in./yr.)
III Moderate Accelerated Erosion (.006 to .010 in./yr.)
IV High Accelerated Erosion (>.010 in./yr.)
V High Normal Erosion—Geological (>.010 in./yr.)
Unclassified
5 0 5 10
SCALE IN MILES
LOCATION MAP
LOCATION MAP OF SUB-BASINS
U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

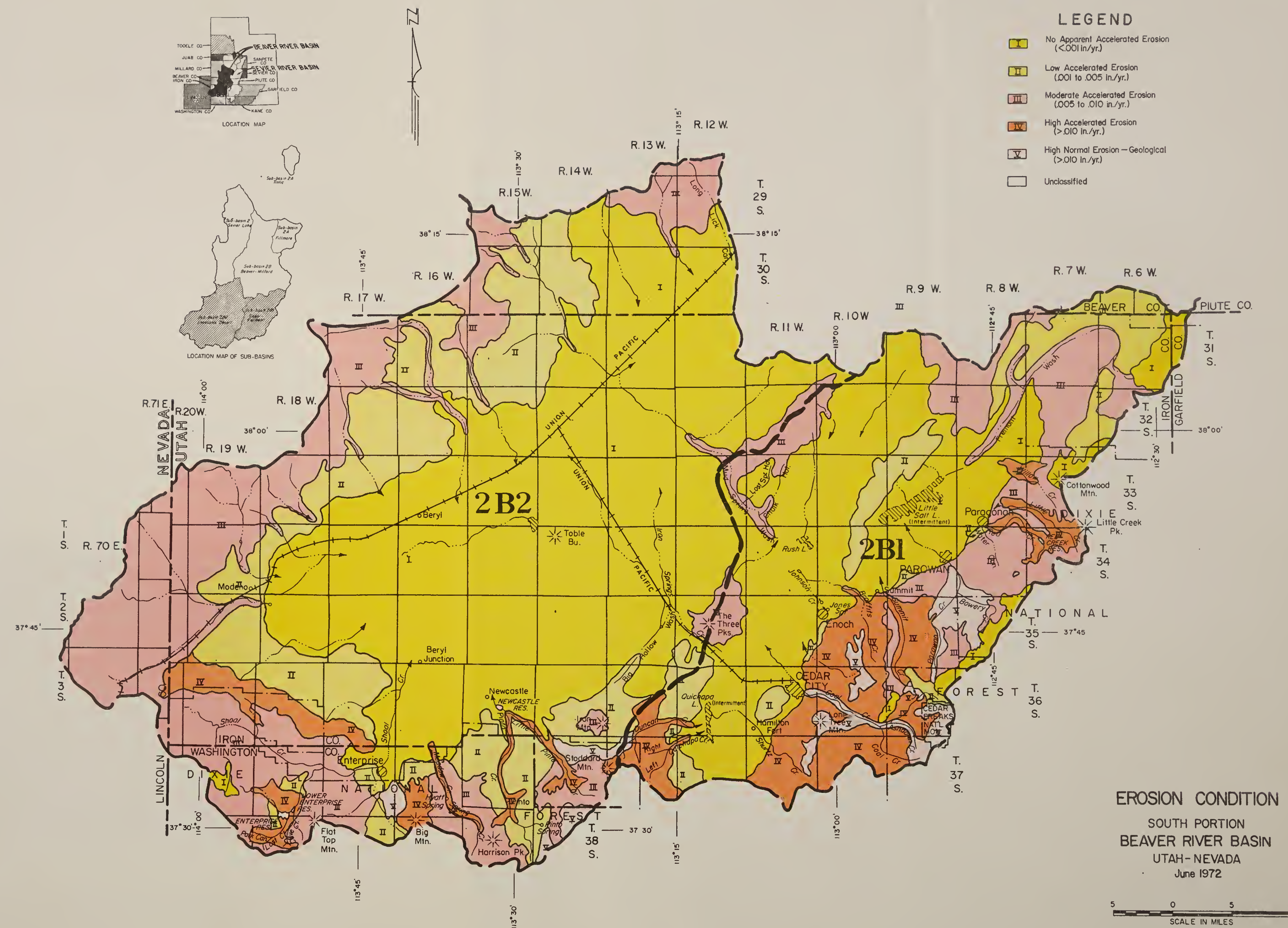

LEGEND
I No Apparent Accelerated Erosion (<.001 in./yr.)
II Low Accelerated Erosion (.001 to .005 in./yr.)
III Moderate Accelerated Erosion (.005 to .010 in./yr.)
IV High Accelerated Erosion (>.010 in./yr.)
V High Normal Erosion — Geological (>.010 in./yr.)
Unclassified
LOCATION MAP
LOCATION MAP OF SUB-BASINS
2B2
2B1
NEVADA
UTAH
LINCOLN
IRON
WASHINGTON
BEAVER
PIUTE CO.
GARFIELD
DIXIE NATIONAL FOREST
Beryl
Beryl Junction
Modena
Newcastle
Enterprise
CEDAR CITY
PAROWAN
Paragonah
Enoch
Summit
Cedar Breaks Natl. Mon.
ERODION CONDITION
SOUTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA
June 1972
SCALE IN MILES

TABLE 34.--Acreage by erosion classes, Beaver River Basin, 1970

Subbasin	Class I	Class II	Class III	Class IV	Class V
	Acres	Acres	Acres	Acres	Acres
2-1 Sevier Lake	492,460	320,680	309,220	0	22,910
2A Fillmore	67,000	168,270	177,730	78,560	0
2B Beaver-Milford	734,900	240,500	415,630	62,610	0
2B1 Cedar-Parowan	299,340	85,320	160,970	113,220	36,040
2B2 Escalante Desert	744,630	278,630	380,340	42,100	11,190
Basin total	2,338,330	1,093,400	1,443,890	296,490	70,140
Percentage of total	44.6%	20.9%	27.5%	5.7%	1.3%

Improperly located and maintained roads are a primary source of erosion and sediment on National Forests throughout the Basin.

STREAM CHANNEL EROSION

Erosion of stream channels presents some special problems. Once streams begin to cut through existing stable alluvium, changes in the character of the stream and adjacent vegetation rapidly occur and are difficult to reverse. Stream channels were evaluated during the summer of 1968. The stream reaches evaluated primarily extend from the headwaters to the first irrigation diversion near the canyon mouth. Most of the distance evaluated was within National Forests. The method[1/] used evaluates each stream reach as (a) stable, (b) moderately eroding, or (c) rapidly eroding (Table 35).

Flood flows gouged out this stream channel in 1959 in South Creek, Beaver Watershed.

1/ Channel Condition Classification, Walter F. Megahan, Intermountain Region, Forest Service, Ogden, Utah.

TABLE 35.--Stream channel conditions in selected watersheds, Beaver River Basin, 1968

Watershed	Perennial stream above first irrigation diversion	Condition of streams based upon rates of channel erosion		
		Stable	Moderate	Rapid
	Miles	Miles	Miles	Miles
2A-24 Chalk Cr.	46.2	0	26.4	19.8
2A-25 Corn Cr.	49.4	8.1	25.0	16.3
2B-1 Beaver	124.7	70.0	29.3	25.4
2B-2 Wildcat Cr.	9.7	7.7	0	2.0
2B1-1 Coal Cr.	71.7	21.7	8.6	41.4
2B1-3 Red Creek	21.5	7.4	5.1	9.0
2B2-1 Pinto Cr.	27.3	8.9	10.4	8.0
2B2-2 Shoal Cr.	16.9	5.1	9.5	2.3
TOTAL BASIN	367.4	128.9	114.3	124.2
		35%	31%	34%

The eight watersheds inventoried provide most of the tributary inflow in the basin. The inventory sample included 188 miles of the total 367 miles of stream within these eight watersheds. These streams have in many instances reached equilibrium between channel depth and width in relation to streamflow despite past erosion problems. Coal Creek watershed had the highest percentage of rapidly eroding stream channels.

SEDIMENT YIELD FROM CRITICAL AREAS

Table 36 indicates acreage of primary and secondary critical areas by drainage, and indicates the sediment yield from these critical areas to the water budget areas and the approximate damage in dollars from this sediment. The procedure used does not adequately take into account sediment yield during flash floods which often produce large volumes of sediment in very short periods. Because the procedure is based on erosion rates modified by characteristics of the land, results may be conservative for frequently flooding streams such as Coal Creek.

Critical areas are defined as (1) areas of erosion greater than .005 inches per year or 0.266 acre-feet per square mile per year; (2) lands yielding significant amounts of irrigation water; or (3) areas with watersheds producing perennial streams with high value for fishing, culinary supply, or power generation. Critical areas are divided into primary and secondary areas. Primary critical areas are eroding at a rate greater than .010 inches per year. Secondary critical areas are eroding at a rate of .005 to .010 inches per year. Primary critical areas are also divided into one category where erosion has been accelerated by man's activities and a second category where erosion is normal or geologic. The primary critical areas of accelerated erosion are those most in need of watershed stabilization. Secondary areas may also be suitable for such treatment but with a lesser priority.

TABLE 36.--Annual sediment yield and damages associated with primary and secondary critical areas, Beaver River Basin

	Critical Area					
	Primary					
Drainage	Accelerated	Normal erosion	Secondary	Total	Sediment Yield	Damages
	Acres	Acres	Acres	Acres	Acre-feet	Dollars
Chalk Creek	8,280	0	16,170	24,450	18.0	$ 8,700
Pine Creek	390	0	2,460	2,850	0.8	400
Meadow Creek	1,390	0	5,770	7,160	1.6	800
Corn Creek	5,020	0	19,030	24,050	5.5	2,700
Walker & Dry	3,420	0	210	3,630	1.4	700
Indian Creek	4,420	0	6,480	10,900	2.1	1,000
Wildcat Creek	30,400	0	39,020	69,420	10.0	4,800
North Creek	0	0	19,520	19,520	8.3	4,000
Beaver River	2,810	0	6,470	9,280	2.1	1,000
South Creek	420	0	7,510	7,930	1.2	600
Little Creek	6,410	0	6,310	12,720	3.0	1,400
Red Creek	4,300	0	10,510	14,810	2.7	1,300
Parowan Creek	4,860	13,190	5,600	23,650	17.0	8,200
Summit Creek	10,890	220	6,240	17,350	9.2	4,400
Braffits Creek	6,560	1,000	0	7,560	7.8	3,800
Fiddlers Creek	6,660	1,900	0	8,560	2.5	1,200
Coal Creek	30,880	16,670	850	48,400	54.4	26,300
Shurtz Creek	14,810	1,230	0	16,040	8.2	4,000
Quichapa Creek	4,450	0	0	4,450	1.6	800
Pinto Creek	4,430	1,410	6,650	12,480	2.7	1,300
Little Pinto	4,950	6,940	13,070	24,960	1.6	800
Meadow Creek	3,900	0	17,800	21,700	2.9	1,400
Spring Creek	0	520	7,770	8,290	1.5	700
Shoal Creek	13,060	0	76,930	89,990	20.8	10,100
TOTAL	172,710	43,080	274,360	490,150	186.9	$90,400

SEDIMENT DEPOSITION

Sediment deposition in reservoirs reduces available storage for recreation and irrigation, decreases water quality, and often destroys esthetic values. Swimming and boating are not popular in many reservoirs because of suspended sediment. Sediment deposition in selected reservoirs is indicated in Table 37. Sediment in streams results in damage to trout habitat, reduces esthetic value, and in general limits the use of water. Productivity of streams for trout is directly related to their freedom from silt.

Spectacular and damaging sediment deposition is frequently associated with flooding of Cedar City urban and residential areas. Other towns are also subject to lessor damages.

Sediment deposition in irrigation systems is an annual problem. The most serious sediment problem occurs in irrigation systems in the Coal Creek watershed. Sediment deposited on cropland smothers vegetation, delays farming operation, inhibits infiltration and reduces crop production. In some areas, cropland has been abandoned due to large deposits of sediment. Crops frequently have to be replanted, and in many cases fields have to be releveled.

Sediment deposition in the upper end of Enterprise Reservoir.

TABLE 37.--Sediment deposition in selected reservoirs, Beaver River Basin, 1965

Item[a]	Unit	Reservoir[b]				
		Minersville (2B-3G)	Beaver Dam #1 (2B-2B)	Yankee Meadow[d] (2B1-1E)	Enterprise Upper #1 (2B2-2B)	Chalk Cr. D.B. (2A-24A)
Total drainage area	Sq.-mi.	510	12	7	27	60.8
Sediment contributing area	Sq.-mi.	490	12	7	27	60
Average annual water inflow	Ac.-ft.	27,500	1,110	1,070	(e)	27,960
Structure age (1965)	Years	50	66	27	55	29
Original capacity	Ac.-ft.	26,500	350	975	9,000	46
Present capacity (1965)	Ac.-ft.	23,260	320	835	8,500	0
Sedimentation:						
Total	Ac.-ft.	3,240	30	140	500	46[c]
Average annual	Ac.-ft.	64.8	0.45	5.2	9.2	(e)
Average annual rate	Ac.-ft./Sq.-mi.	0.132	0.038	0.74	0.34	(e)
Average annual storage capacity loss	Percent	0.24	0.13	0.53	0.10	(e)

[a]Additional information for existing reservoirs given in Chapter IV.
[b]Site number is for reference only for location on map following page 28.
[c]Debris basin filled the same year it was built.
[d]Data since enlargement.
[e]Data not evaluated.

F L O O D D A M A G E S

Flood problems of varying magnitude occur throughout the Basin. A hydrologic and economic analysis was made of flood damages associated with various frequency events. Damages were based on 1970 conditions. Peak flows were determined for the 1 percent and 10 percent frequency events for selected drainages. Flood damages were also estimated (Table 38).

Damages at Cedar City, the highest in the Basin, were estimated for the 1 percent event at 2 million dollars and the average annual estimated flood damages are $304,880.

Flooding also occurs where the flood plain is not inhabited and flood damages occur to stream channels, transportation systems, and to forest and range improvements.

Watershed stabilization and protection is needed on critical areas to help prevent floods. Some streams and drainages need reservoirs or other flood control structures to reduce flood peaks and damages to downstream facilities. Those drainages with first priority needs are shown in Table 38.

Road and bridge washed out in a flood on the South Creek Drainage, Beaver Watershed, 1959.

TABLE 38.--Summary of floods, Beaver River Basin

Drainage	Town	Peak flow 1 percent event	Peak flow 10 percent event	Peak flow 1 percent event	Peak flow Average Annual
		CFS	CFS	Dollar	Dollar
Tintic Wash	Eureka	365	125	10,700	420
Chalk Creek	Fillmore	3,000	1,200	101,000	7,600
Corn Creek	Kanosh	1,630	435	19,700	980
Beaver River	Beaver & vicinity	1,850	560	21,000	2,000
North Creek	Beaver & vicinity	1,295	173	21,000	1,200
South Creek	Beaver & vicinity	900	190	6,000	320
Center Creek	Parowan	4,000	1,300	495,000	22,720
Summit Creek	Summit	3,100	800	183,000	7,940
Fiddlers Creek	Cedar City & vicinity	2,900	1,400	80,000	10,400
Dry Canyon	Cedar City & vicinity	870	0	0	17,150
Coal Creek	Cedar City	6,400	2,600	2,000,000	304,880
Shoal Creek	Enterprise & vicinity	3,600	500	398,000	11,500
				TOTAL	387,110

Flood damages in 1959 in the Cedar City area included channels and culverts plugged with debris (above); irrigation ditches filled with mud, and flooded cropland (below).

M U N I C I P A L & I N D U S T R I A L W A T E R S U P P L Y

Municipal and industrial water problems relate to inadequate facilities and treatment to supply good quality water to the scattered communities. If adequate facilities are provided, high quality water, rated acceptable for human consumption, is generally available in sufficient supply to meet present needs. Cedar City, however, will need to increase its supply of water if the population continues to increase.

I R R I G A T I O N W A T E R P R O B L E M S

Irrigation problems are related to variations in supply from year to year and during each year, quality of irrigation water, distribution and conveyance problems, inefficient water application on farms, and drainage. During the 1956 to 1965 period, the basin experienced below normal precipitation which tended to accent normally recurring water shortage problems. Because agriculture provides the primary economic base, changes in available irrigation water can account for variations in basin income. There is a need to overcome consumptive use deficits. Part of this could be accomplished with reservoir developments that help offset wide fluctuations and provide late season irrigation water supplies; and by irrigation improvements that increase overall irrigation efficiencies and increase utilization of available water.

WATER SUPPLY VARIATIONS

Variations from year to year, as well as between individual months within the year are characteristic of the basin's water supply. Annual fluctuations in streamflow vary with precipitation. Ground-water recharge generally shows the same cyclical patterns as streamflow, but use is in excess of recharge and ground-water levels are declining. Ground water is the main source of irrigation water in some areas and provides supplemental water in other areas.

Timing is a problem because most irrigation surface water diversions are made from streams lacking seasonal regulation. In most years there is unused root-zone water from November through April when plants are dormant. Usually there is a deficit in moisture during the growing season of May through October (Figure 9). In the Fillmore subbasin, which is without reservoirs, 28 percent of the total diversions occur from June through August. By contrast, the Escalante Desert subbasin, which has three reservoirs for regulating water, 63 percent of total surface water diversions occur during this same period.

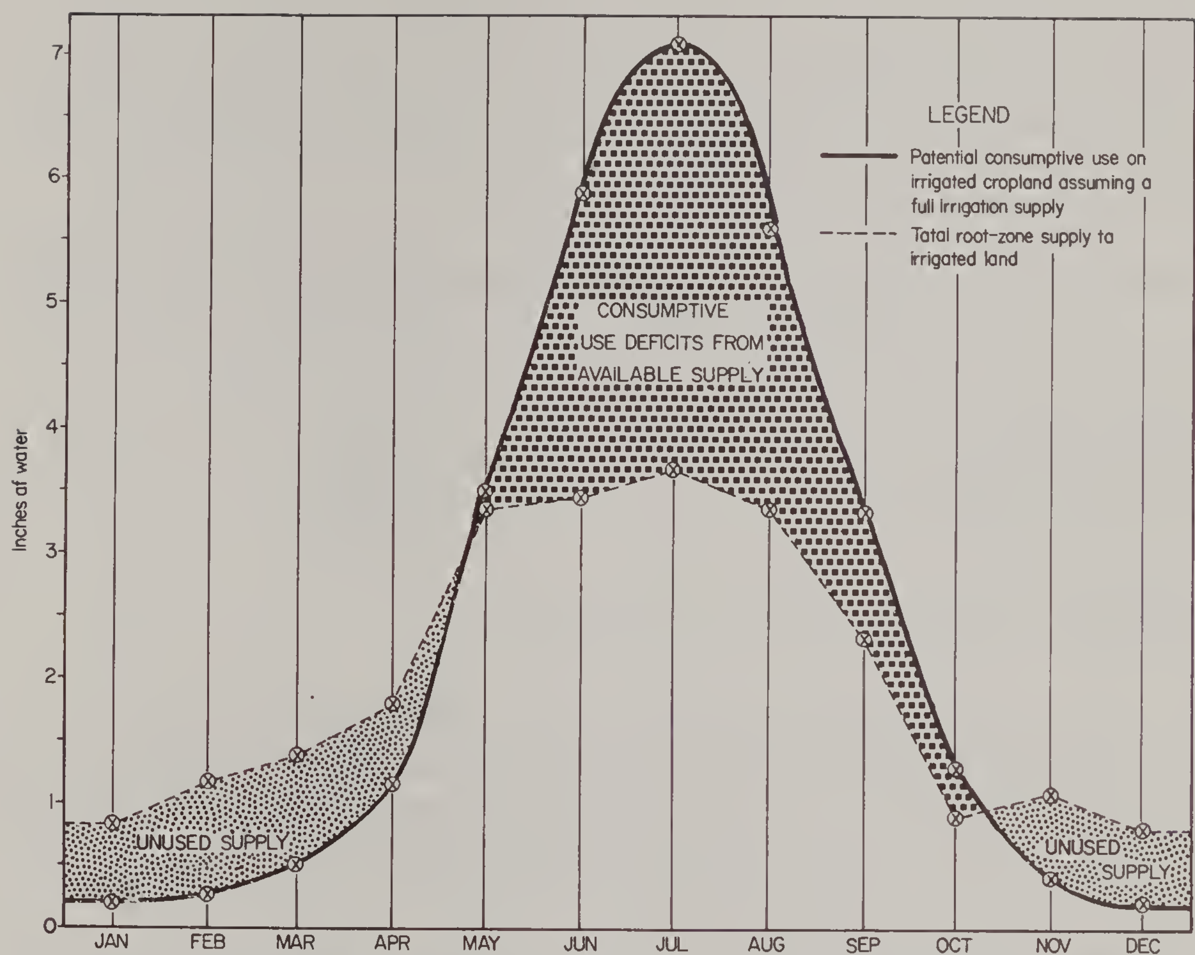


Figure 9: Relationship between monthly total root-zone supply and potential consumptive use, Beaver River Basin.

Unused root-zone supply for the years 1956-65 averaged 16,560 acre-feet annually. This water then evaporates, transpires, or percolates to ground water. Consumptive use deficits in the basin average 62,470 acre-feet for the 1956-65 period as shown in the following tabulation. This is 25 percent of the approximate 252,500 acre-feet of potential consumptive use.

Subbasin	Average Consumptive Use Deficit (acre-feet)
Fillmore	23,140
Beaver-Milford	7,280
Cedar-Parowan	20,110
Escalante Desert	11,940
Basin	62,470

The withdrawal of ground water has increased greatly since the 1940's. As an example, total withdrawal from wells in the Pavant Valley has increased from 18,000 acre-feet in 1946 to 67,000 acre-feet in 1960. The number of pumped irrigation wells has increased from 2 to 110 in the same period. This large increase in use has caused the quantity of water pumped to be greater than the ground-water recharge. If this trend continues, pumping costs will increase as greater lifts are required. The average change in ground-water storage for the period 1956-65 is given in the following tabulation.

Ground-water reservoir	Average change in ground-water storage (acre-feet)
Pavant Valley	-11,110
Beaver Valley	+ 2,760
Cedar-Parowan Valley	- 7,080
Escalante Valley[a]	-20,560
Basin Total	-35,990

[a]Includes Minersville-Milford Watershed

Decreases in ground-water storage have caused average declines in ground-water levels of 10 to 50 feet during the 1956-65 period. The largest declines occurred in the Escalante Desert and Fillmore subbasins. Declining water levels have increased the cost of pumping, well development, and maintenance of existing wells. Declining ground-water levels have also caused increased salt content in the water and decreased ground-water outflows. Declining ground-water levels in the Fillmore subbasin have decreased the flow to Clear Lake Springs. Figure 10 indicates the cumulative change in ground-water storage for the major ground-water reservoirs.

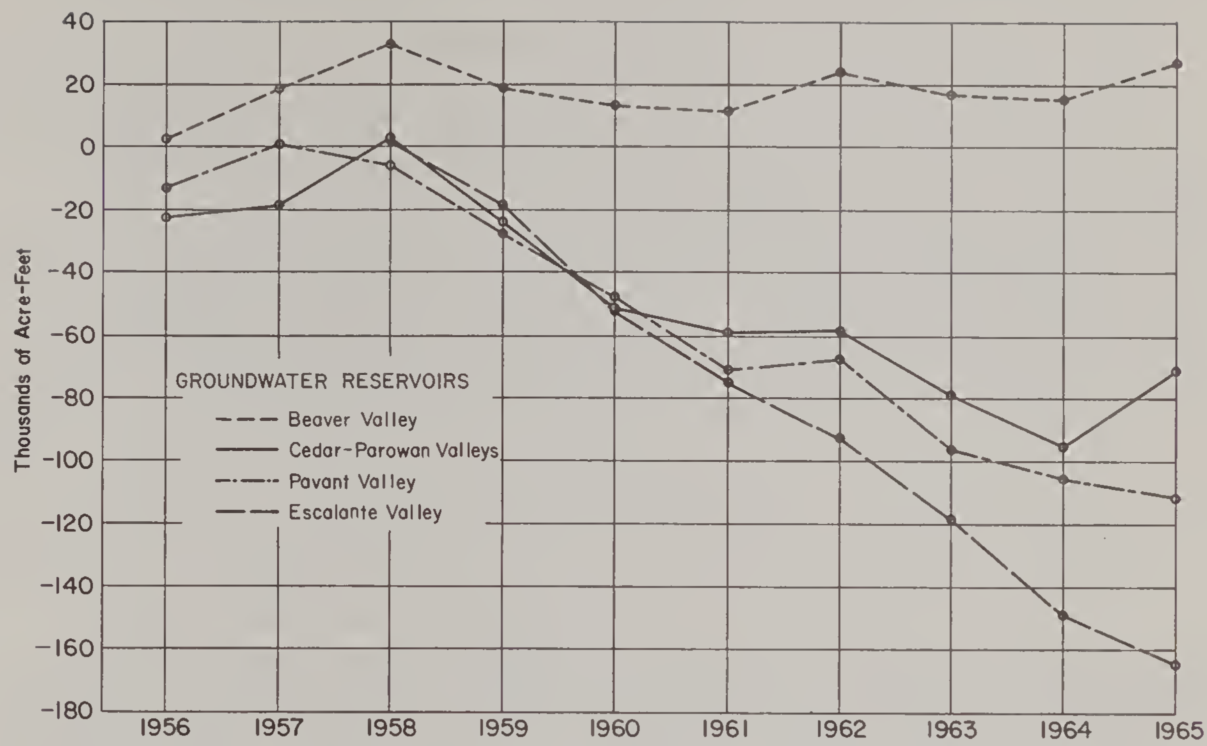


Figure 10: Cumulative change in ground-water storage by ground-water reservoirs. Beaver River Basin, 1956-1965

SOURCE: Beaver River Basin, Appendix II "Water Budget Analysis Supplement"

DISTRIBUTION AND CONVEYANCE SYSTEMS

Major problems include conveyance losses, inadequate or insufficient structural measures, and company organization and management problems. Legal and institutional procedures defer needed improvements in some locations. Conveyance losses are caused by seepage, evaporation, transpiration by riparian vegetation, and leaky headgates and burrowing animals. Canals in the Meadow area are in good condition with a conveyance efficiency of 90 percent, while those in the Beaver-Greenville area are in poor condition with a conveyance efficiency of 64 percent.

Some irrigation companies could be reorganized and better managed. Services and facilities are frequently duplicated. More efficient operation and maintenance as well as better design and construction could be provided if irrigation companies with

overlapping service areas and parallel facilities were combined. Most diversion dam structures or main canals are capable of satisfactory service if properly managed. However, some new structures and repair or replacements of others are needed.

WATER APPLICATION

Principal causes of inefficient water use are improper application, inadequate land treatment, and lack of on-farm structures. On-farm irrigation efficiencies in 1965 varied from 37 percent in the Parowan area to 50 percent in the Minersville-Milford area. Some irrigated land is steep and could be more efficiently irrigated with sprinkler systems. Improved field layout, correct length of irrigation runs, land leveling, and other practices are needed in many cases.

D R A I N A G E

There are 17,880 acres of phreatophyte and nonirrigated wet lands which receive a full or partial water supply from ground-water sources. This phreatophytic vegetation is valuable for grazing, wildlife, and esthetics but it consumes 21,480 acre-feet of water that could be used for irrigation or other purposes. However, the wetland areas are scattered and cannot be readily drained. Future improvements in irrigation systems, and methods, will reduce return flows from irrigation which provide part of the supply to wetlands.

L A N D   U S E   A N D   M A N A G E M E N T

Better use and management is needed to protect existing resources and to apportion finite resources among user demands which are often conflicting. Past levels of disease, insect and fire occurrence have been controlled within levels of economic justification in relation to damages. There will be a need to maintain existing levels of protection, and to increase protection as resource values increase. There also may be localized protection needs that are not identified by this study. The recent surge in recreation home development results in a need for careful balance between proprietary rights of the land owner and problems occurring to society. There is a need to protect health and quality of life through adequate land use planning and related zoning and construction ordinances.

Complex ownership patterns lead to a need for cooperation among owners. Easements, exchanges and purchases are needed to make resources more readily available and to permit more efficient use.

Disease problems on forest, range and cultivated lands affect native vegetation and crops. Diseases are caused by fungi, rust, cankers, bacteria, and viruses as well as other organisms which affect the physiology of vegetation.

Primary forest insects include bark beetles such as the mountain pine beetle and the western pine beetle. Defoliators include tent caterpillars, larch miners, and the pinyon needle scale. Rangeland chewing insects include grasshoppers, mormon crickets, cutworms, tent caterpillars, leaf miners and others. Sucking type rangeland insects include aphids, myrid bugs, leaf hoppers, false cinch bugs, and stink bugs. Block grass bugs are causing extensive damage to crested wheatgrass. A wide variety of insects also cause significant crop damage. Vegetable gardens harbor specific insects which cause severe local losses. Weevil and aphids are troublesome in alfalfa.

Fire is another land management problem. About 10 fires each year burn on National Forests, 10 on public domain, and 12 on state and private lands. Fires range in size from very small, to major fires such as the Baldwin Ridge fire in the Beaver watershed that covered 2,200 acres.

The construction of summer home residences and subdivisions without full regard to proper location or adequate utility provisions is causing many land use and management problems. The Beaver River Basin is near enough to Las Vegas, Nevada, and population centers of southern California to be desirable for second homes or vacation homes. Developments are frequently adjacent to streams that should remain free to public access, fishing, and enjoyment. Resources and esthetic values are being destroyed by construction, contamination of surface and underground water, and improper disposal of garbage and waste. Fire hazard increases when cabins and similar developments are placed among flammable forest type vegetation.

Complex ownership patterns where state and private lands are scattered throughout public lands lead to many administrative problems and confusion to land users. Laws, rules, and regulations vary for each land category. Unmarked boundaries lead to unintentional trespass problems. Management of one ownership is often affected by management of other ownerships. Private owners in some cases are able to restrict the use of public lands by controlling access to them.

Subdivision and development on private forested land often results in resource losses and environmental problems.

E N V I R O N M E N T A L   P R O B L E M S

If the enviable quality of life in the Beaver River Basin is to be maintained, there is a need for vigilance in preventing environmental deterioration. People will increasingly look to areas such as this for opportunities to avoid problems associated with population concentration. The present high quality environment needs to be recognized as one of the important resources that is rapidly increasing in value.

The spectrum of environmental concerns ranges widely from the impacts on natural resources--air, water and land--to the impacts on people, esthetics, and cultures. Within the broad range of this concept, all problems described in this report are "environmental problems". This section addresses itself to some additional problems related to the natural environment.

Stable and healthy biotic communities are characterized by a wide variety of plant and animal life. Grazing impacts have changed vegetation on vast areas from communities of a balanced variety of forbs, grasses and browse to predominantly browse. Widespread starvation of deer, declining sage grouse, failure of antelope to increase, and other problems are related to such changes in vegetation. Winter habitat for deer has been lost to cultivation and has been affected through construction of freeways that destroy habitat and isolate deer by blocking migration routes. Habitat for trout has been damaged to the extent that most populations can be maintained only through artificial propagation except within the Beaver Watershed.

Water pollutants include those from sediment, dissolved solids (soluble salts), organic substances, temperature, and biological contamination. Most streams in the mountain areas have a low content of dissolved solids. Concentrations generally increase in the lower reaches of the streams where return flows and seepage waters make up a high proportion of the streamflow volume. For example, a water sample taken from the Beaver River near Beaver on July 13, 1950, showed 75 mg/l dissolved solids. A sample taken about 8 miles downstream at Adamsville on the same day showed 540 mg/l. The greatest increases in salt concentration occur during periods of low flow and large irrigation diversions.

Ground water varies considerably in salt content from area to area. Published data indicate about 46 percent of the wells have low salinity hazard, 36 percent have medium, 16 percent have high and 2 percent have a very high salinity hazard. In the Pavant and Escalante Valleys, the concentration of most chemical constituents has increased as ground-water depletions have increased.

Organic and biological pollution includes that caused from waste water, sewage, feedlots, and slaughter houses. Fillmore, the second largest city within the Basin, has contracted for a modern central sewage collecting system, part of which has been installed. Beaver City presently dumps raw sewage into the Beaver River. Cedar City sewage is treated by a trickling filter-type installation. Obnoxious odors are frequent in the vicinity of the treatment plant. Other communities primarily rely on septic tanks to dispose of sewage. Septic tank disposal problems vary depending on water table levels, location of culinary wells in relation to septic tanks, the number of septic tanks within a given area, and soil characteristics.

Air pollution consists mainly of particulate dust from the power plant on Coal Creek when it's operating, the mulch plant near Cedar City, and open burning. Open burning is now prohibited by law except that cities and counties can obtain temporary variance to the law provided they have a plan for installing a sanitary land fill soon. Open burning is thus being phased out. Other limited pollution is more of an esthetic problem, due to solid particles accompanied by temperature inversions, than a health hazard. Smog, haze, and foul odors, common to most cities, cause some concern.

Radioactive substances such as strontium 90 are a residual hazard in the Basin because of proximity to atomic testing areas in Nevada. As water from rain or melting snow accumulates, these harmful substances are concentrated in streams and ground-water supplies.

The effects of the use of compounds containing cumulative and persistent substances such as mercury, arsenic, dieldrin and DDT on human life have not been fully evaluated. Persistent compounds such as DDT are causing predatory birds to diminish. Hunters are now cautioned about killing pheasants for human consumption because of mercury contamination traced to the use of fungicides on grain. Other compounds such as hydrocarbons 2-4D or 2-4-5T, and nonpersistent pesticides are less likely to cause direct damage but far reaching ecological changes do result. A certain amount of irrationality due to a lack of knowledge concerning the effects of these substances is now prevalent. The use of pesticides such as 1080 to control predators has been restricted on public lands.

CHAPTER VII

EXISTING PROJECTS AND PROGRAMS

Existing water and related land resource projects and programs are described. These projects and programs assist the people in achieving better utilization and management of resources through technical and financial assistance.

WATERSHED PROTECTION AND FLOOD PREVENTION PROJECTS

Under the Watershed Protection and Flood Prevention Act one watershed project has been completed, one is under construction, one is authorized for planning and one was authorized for planning and then terminated.

The Green's Lake Watershed (2B1-2), which contains 6,235 acres, was authorized for construction in April, 1957 and completed in March 1959. This project diverts floodwater flows from the Green's Lake area into Cross Hollow to the south and protects the developing area in the south edge of Cedar City. Structural measures included four debris basins, one retarding dam, and an earth-concrete flood channel. Land treatment measures included pinyon-juniper clearing, seeding, and fencing.

The Minersville Watershed (2B-3, 2B1-6, 2B2-5) covers 249,000 acres. The area includes the main stem of the Beaver River from below Minersville Reservoir to Milford. It was authorized for construction in May, 1965, and is under construction. Primary objectives include erosion reduction, sediment and floodwater damage prevention, and more efficient irrigation and livestock water delivery and use. To accomplish this project, land treatment measures include range reseeding and management, livestock and wildlife water developments, and on-farm treatment measures. Structural measures include two debris basins, an irrigation water diversion dam, pipelines and canal lining.

Coal Creek Watershed project (2B2-1) and a small area outside the Basin covers 245,000 acres. The area encompasses the drainages of Parowan, Summit, Coal, Kanarra, and Kolob Creeks and the headwaters of Crystal and Deep Creeks. Planning was authorized January 1956, terminated September 1959, and reauthorized July 1967. Problems include extensive sediment and floodwater damage and inefficient use of irrigation water and projected municipal and industrial water shortages.

A watershed project on Chalk Creek which included 36,000 acres of the Chalk Creek Watershed (2A-24) was authorized for planning in January 1955 and terminated in August 1956. Problems include floodwater and sediment damages and a late-season water shortage in the Fillmore area.

SOIL CONSERVATION DISTRICT PROGRAMS

All or parts of five soil conservation districts serve the area within the Beaver River Basin; Beaver, Delta, E and I, Millard County, and Twin M. Only a small area of the Basin is served by the Delta SCD in the relatively undeveloped area northwest of Fillmore and toward Sevier Lake.

These districts are all active and providing assistance to over 1,000 of the 1,400 farm operators through cooperative agreements. Through these agreements, cooperators obtain technical assistance from the Soil Conservation Service, Forest Service, Bureau of Land Management, and other agencies with memoranda of understanding to assist with conservation practices and related activities. SCD's also work with irrigation companies and groups, drainage districts, communities, recreation groups, political entities, and others as needed.

CONSERVATION OPERATIONS PROGRAM

Many activities are carried out by the Soil Conservation Service within the scope of the conservation operation program under PL-46. These include assistance to 5 soil conservation districts, conducting snow surveys to provide water supply forecasts at 4 stations, coordinating the National Soil and Water Conservation Needs Inventory, and providing technical assistance to the Rural Environmental Assistance Program, Farmers Home Administration credit program, and Rural Areas Development program.

High intensity soil surveys have been completed on 1.13 million acres of private and State lands in 4 soil survey areas. Lower intensity surveys of various types cover most of the remaining areas.

Assistance has been provided to 960 district cooperators in developing conservation plans for nearly 1.3 million acres of private, State, and other lands. The following tabulation indicates part of the accomplishments within the scope of these plans by 1965.

Land leveling	50,800 acres
Sprinkler irrigation systems	3,100 acres
Canal and ditch lining	323 miles
Irrigation structures	19,500 each

RESOURCE CONSERVATION AND DEVELOPMENT PROJECTS

Under the Food and Agriculture Act of 1962, the U.S. Department of Agriculture, with Soil Conservation Service providing leadership, gives technical and financial assistance to local groups in resource conservation and development projects. Purpose of the projects is to establish better economic conditions in rural areas. Other federal, state, and local agencies also assist as appropriate.

Project measures are carried out through local sponsors who also provide much of the financing. Also, federal agencies accelerate their on-going programs to assist, both technically and financially.

The Color Country Resource Conservation and Development project (authorized in 1972) covers part of the Beaver River Basin. Beaver, Garfield, Iron, Kane, and Washington counties are included. Preparation of the Plan of Action is now underway.

AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE PROGRAM

The Agricultural Stabilization and Conservation Service has provided financial assistance for installing conservation practices to nearly all farm and ranch units. The extent of the assistance in 1966 is indicated in Table 39.

TABLE 39.--Conservation practice cost sharing, Beaver River Basin[a], 1966

County	Participants	Cost Sharing
	(Number)	(Dollars)
Beaver	65	29,355
Iron	90	87,247
Juab	96	28,939
Millard	404	107,568
Total	655	253,109

[a]Figures for counties lying partly within the Basin include the entire county.

F A R M E R S   H O M E   A D M I N I S T R A T I O N

The Farmers Home Administration has provided financial assistance and advice to residents of the Beaver River Basin. Loan participants and values for 1966 are shown in Table 40.

TABLE 40.--FHA loan status, Beaver River Basin, 1966

County[a]	Real estate loans	Amount	Non-real estate loans	Amount
	(number)	(dollars)	(number)	(dollars)
Beaver	140	1,756,156	34	198,982
Iron	181	3,404,640	75	795,463
Juab	71	634,370	14	68,102
Millard	149	1,521,848	50	108,219
Total	541	7,317,014	173	1,242,766

[a]Figures for counties lying partly within the Basin include the entire county.

N A T I O N A L   F O R E S T   D E V E L O P M E N T   A N D   M U L T I P L E - U S E   P R O G R A M S

Parts of the Fishlake and Dixie National Forests, containing 563,430 acres are within the Basin. These lands are managed to provide resources and uses for a rapidly expanding population within Utah and neighboring states. These lands yield over 88 percent of the tributary water inflow. Watershed management is, therefore, an important program and resources are harvested with careful consideration to water values. As part of National Forest Development and multiple use programs 4,350 acres of critical flood producing area, 3,260 acres of roads and trails or disturbed area, and three miles of gullies have been stabilized. Range forage improvement on an additional 17,215 acres also contributes to good watershed conditions as well as providing part of the forage for 36,030 AUM's of grazing.

People enjoy about 180,000 visitor days of recreation annually on the two National Forests while participating in a wide variety of activities from skiing to hunting. Over three-fourths of the recreation use is from people residing outside Utah, primarily from Nevada and California. Many people harvest forest products as part of their recreation and some commercial use is made of forest products.

About 1.5 million board feet of saw timber is harvested annually as well as pinyon nuts, Christmas trees and ornamental trees. The varied species of fish and wildlife add to recreation enjoyment and management of their habitat is an important program.

The Basin area is served by the Intermountain Forest and Range Experiment Station, part of the research arm of the Forest Service. Insect and disease surveillance is conducted and extensive range research projects are underway at the Desert Range Research Station near Milford.

OTHER PUBLIC LANDS AND DEVELOPMENT

The Bureau of Land Management administers the public domain. These lands are protected from fire, insects, and erosion and are managed to provide a combination of uses. Improved watershed conditions have largely been accomplished by replacing pinyon-juniper and sagebrush with grass to provide better soil protection and improved grazing. Forage improvement on nearly 100,000 acres had been completed by 1970. Pinyon-juniper has been removed on areas to allow growth of native grasses without seeding.

Cedar Breaks National Monument, administered by the National Park Service, lies mainly within the Basin. This unique area annually attracts thousands of visitors, which adds to the Basin's economy. The primary management goals are to preserve its beauty and associated plant and animal life, and to provide interpretative services and facilities for the convenience and safety of the tourists.

The Corps of Engineers has authority under the Flood Control Act of 1938 to investigate the flood and related water resource problems on streams such as the Beaver River. One flood control project west of Milford was completed in 1959 by the Corps.

COOPERATIVE STATE-FEDERAL FORESTRY PROGRAMS

The Forest Service is responsible for leadership in cooperative forest management and protection on approximately 51,500 acres of private, state and other non-federal forested lands. Technical assistance and advice is provided through the Utah State Forester's office and Utah State Extension Service.

STATE DEVELOPMENTS

The Division of Water Resources under authority of Title 73, Utah Code, conducts studies and investigations, and prepares plans for the development and utilization of water resources. Development of a State Water Plan is underway and is scheduled for completion by 1975. They have provided significant contributions through financial and technical assistance to 17 water conservation projects within the Basin. The number of projects, cost, and amount of interest free loans to sponsors through fiscal year 1964 are tabulated below.

	Number	Total cost	Division Water Resource loan
Beaver	6	278,242	216,554
Iron	5	438,065	312,847
Millard	5	152,661	110,201
Washington	1	157,979	77,000
	17	1,026,947	716,602

The Division of Parks and Recreation has established a State historic site at Fillmore, the first capital of Utah, and a boating park with related facilities at Minersville Reservoir. The Division of Wildlife Resources operates a fish hatchery near Beaver. Large blocks of land are managed to provide winter habitat for deer. On much of this area, pinyon-juniper has been removed and the area seeded to grasses and browse plants to provide more desirable forage. On some State lands, improvement work was completed by the Forest Service under provision of the Granger-Thye Act. Other State lands, normally four sections in each township, are administered by the State Land Board. These lands are managed to provide a maximum monetary return to the State, and are commonly leased to private individuals for grazing or other purposes.

CHAPTER VIII

DEVELOPMENT POTENTIAL

This chapter describes potential water and land resource development within the Basin. Physical potential for development is discussed without identification of specific projects and programs. Major categories include water, land, and recreation resource development.

WATER RESOURCES

Potential water resource development is directed towards reducing water shortages, sedimentation, flooding and increasing recreation. Irrigation alternatives include increasing water conveyance and on-farm irrigation efficiencies, providing surface water storage, and increasing ground-water pumping, or a combination of these measures. These alternatives will increase the utilization of the available supply, but will generally result in a decrease of return flow to streams and ground-water recharge. In most areas this will accelerate declining water levels. Further study of development impacts on ground water resources is needed.

IRRIGATION IMPROVEMENTS

One way of realizing additional benefits from the existing water supply is to improve water use efficiency. Water use efficiency was evaluated in two parts -- off-farm conveyance and on-farm application.

Delivery systems can be upgraded by lining across high loss areas, using efficient diversion structures, and installing effective measurement and management controls. The consolidation of parallel canal systems has potential. There is an opportunity to line over 290 miles of canals and laterals which would increase off-farm conveyance efficiencies by 22 percent.

Irrigation practices on individual farms have more potential to improve water use and management than any other activity. There is opportunity to install sprinkler systems or land leveling on 53,800 acres and to line over 770 miles of farm ditches. This could increase from the present 44 percent to 62 percent.

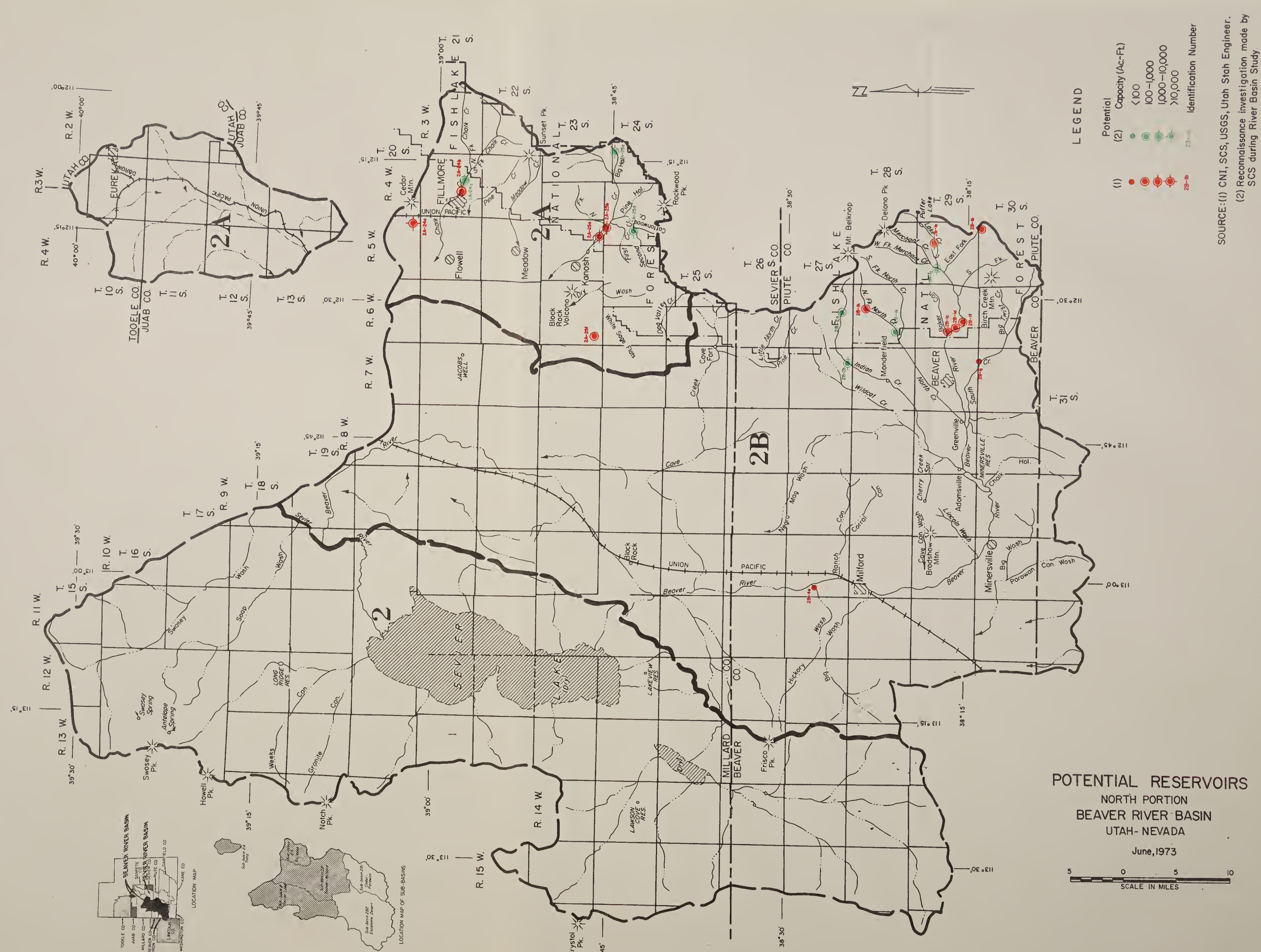
If both on-farm and off-farm potential irrigation improvements were made, the overall water use efficiency could almost double from the present 33 percent to 60 percent. This could reduce existing root-zone consumptive use deficits by over 44,200 acre-feet, but would not eliminate the entire water shortage.

SURFACE RESERVOIRS

Many potential storage sites have been investigated by the State Engineer, U. S. Geological Survey, local organizations, and others. Approximately 50 potential reservoir sites were identified which could provide over 133,000 acre-feet of storage with 5,000 acres of surface area. Most of these sites are poorly suited for water storage due to geologic conditions, lack of available water, or other limitations. Water resource problems cannot be completely solved by additional surface water storage. Table 41 gives a summary of potential reservoirs, and their location is shown on the map following page 108.

UNDERGROUND RESERVOIRS

The portion of the Pavant Valley underground reservoir within the Basin contains 7.4 million acre-feet of water in the upper 300 feet of alluvium. The other four underground reservoirs each probably contain an additional several million acre-feet of water. There is opportunity to develop and accelerate mining this water source as an alternative. Current use is lowering water tables in each reservoir except Beaver Valley. The base period mining, a period of below average precipitation, of nearly 36,000 acre-feet annually represents only a small portion of the remaining storage. A predetermined mining rate could conserve this resource for a considerable length of time. Presently, development of new wells, and pumpage of existing wells is controlled by the Utah State Engineer.



POTENTIAL RESERVOIRS

NORTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA

June, 1973

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

POTENTIAL RESERVOIRS
SOUTH PORTION
BEAVER RIVER BASIN
UTAH - NEVADA
June, 1973

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

RW38-T1

TABLE 41.--Potential reservoirs, Beaver River Basin, 1965

Name	Number[a]	Stream	Location T	Location R	Location S	Capacity	Surface area	Drainage area	Purpose[b]	Remarks	Source of information[c]
						Ac. ft.	Acres	Sq. mi.			
Chalk Creek Watershed (2A-24)											
Chalk Creek Lower	2A-24b	Chalk Creek	21S	4W	28	4,000	100	60.0	I, PC, S		SCS
Chalk Creek Upper	2A-24a	Chalk Creek	21S	4W	27	7,444	152	58.0	R, I, FC, S, M&I	e	SCS
Chalk Creek Delta	2A-24c	Chalk Creek	20S	5W	36	15,000	620	94.0	I, R		SCS
Corn Creek Watershed (2A-25)											
Adelaide Lower	2A-25a	Corn Creek	23S	5W	35	2,500	46	87.0	I, PC, S		SCS
Adelaide Upper	2A-25b	Corn Creek	24S	4½W	5	1,000	35	85.0	I, PC, S		SCS
Big Hollow	2A-25c	Big Hollow, Corn Creek	24S	4W	4	4,034	142	2.2	I, R	e	SCS
Cottonwood	2A-25d	Second Creek, Corn Creek	24S	4½W	8	2,365	66	12.2	I, FC, R	e	SCS
Wide Hollow	2A-25f		23S	6W	31	700	27	20.0	PC, S, R		SCS
Beaver Watershed (2B-1)											
Britt's Meadow	2B-1a	Lake Stream	29S	5W	15	1,660	(80)[d]		I, PC		U
Dry Flst	2B-1b	East Fork of Beaver River	30S	5W	1	112	(8)				U
Lewis Power #1	2B-1c	Besver River	29S	6W	20	930	(50)		P		U
Lewis Power #2	2B-1d	Besver River	29S	6W	20	935	(50)		P		U
Lewia Power #3	2B-1f	Beaver River	29S	6W	28	214	15		P		U
North Pork North Creek	2B-1h	North Fork North Creek	28S	6W	10	620	(36)				U
North Creek	2B-1k	North Creek	28S	6W	29	790	26	14.1	I, PC, R	e	SCS
South Creek	2B-1j	South Creek	30S	7W	2						U
Three Creek Lower	2B-1g	Beaver River	29S	5W	17	3,220	84	37.8	PC, R	e	SCS
Three Creek Upper	2B-1m	Beaver River	29S	5W	9	4,700	108	17.0	I, FC	Enlargement	USGS
Wildcat Creek Waterahed (2B-2)											
Indian Creek Diversion	2B-2b	Indian Creek	27S	7W	35	1,110	40	19.9	I, PC, R	e	SCS
Milk Ranch Reservoir	2B-2a	Indian Creek	27S	6W	34	800	32	8.8	I, R	e	SCS
Milford Watershed (2B-4)											
Fartheringham	2B-4a	Beaver River	27S	16W	18						
Coal Creek Waterahed (2B1-1)											
Ashdown Creek	2B1-1a	Ashdown Creek, Coal Creek	36S	10W	36	10,000	(400)		P, R, FC, I		SCS
Bauer	2B1-1b	Jones Ditch	35S	11W	34	40	10		I		U
Blue Valley	2B1-1c	Blue Valley Creek	37S	12W	17	180	(13)	5.0	PC, I		SCS
Center Creek	2B1-1d	Bowery Pork, Center Creek	35S	8W	9	150	(11)		I, R, P	Aka Yankee Meadow Alt.	SCS
Dry Canyon	2B1-1f	Dry Canyon	36S	11W		150	(11)	3.0	PC		
Piddlers	2B1-1g	Fiddlers Canyon	35S	11W	36	500	(30)	12.0	PC		
Hamilton Port	2B1-1h	Shurtz Creek	36S	11W	29	400	(25)	7.0	PC, I		SCS
Harris Gubler	2B1-1j					31	(3)				
Jenny Beck	2B1-1m	Center Creek	36S	9W	2						
Parawon	2B1-1n	City Creek	34S	9W	15	6,000	(260)	70.0	I, PC		SCS
Red Hill	2B1-1p	Coal Creek	36S	11W	13	17,000	(630)	81.0	PC, S, I, P, R, M&I	f	SCS
Shurtz	2B1-1q	Shurtz Creek	37S	11W		300		7.0			
Summit	2B1-1r	Summit Creek	34S	10W	36	1,500	(80)	24.0	I, FC		SCS
Urie	2B1-1s	South Creek, Coal Creek	37S	10W	8						
Yankee Meadowa	2B1-1t	Center Creek	35S	8W	20	1,225	61	7.0	I, R, P,	Enlargement	USCS
Misc. DB's	2B1-1u	Near Cedar	36S	11W		500	(30)	10.0	FC		SCS
Red Creek Watershed (2B1-3)											
Little Creek	2B1-3a	Little Creek	33S	7W	32	1,100	59	11.8	I, R	e	SCS
Pinto Creek Watershed											
Blue Grass Flat	2B2-1a	Little Pinto, Pinto Creek	36S	15W	26,27	9,467	351	126.0	I		USGS
Herdhouse	2B2-1b	Pinto Creek	37S	15W	2,3	569	45	47.0	I		USGS
Holt Canyon	2B2-1c	Meadow Creek	37S	16W	10	1,250	80	31.7	I, R	e	SCS
Newcastle	2B2-1f	Pinto Creek	36S	15W	22	26,000	(975)	133.0	I	Enlargement	SCS
Pinto	2B2-1g	Pinto Creek	37S	15W	27	(500)	(30)		I		SCS
Upper Pinto	2B2-1h	East Pork, Pinto Creek	38S	15W	1	1,060	57	10.3	R	e	SCS
Shosl Creek Watershed											
Calf Springs	2B2-2a	Calf Springs Creek	37S	17W	27	601	36	12.00	Mult.		USGS
Cottonwood	2B2-2b	Cottonwood Creek	37S	16W	29						
Holt	2B2-2c	Shoal Creek	37S	17W	16			111.00			SCS
Indian Rock	2B2-2f	Shoal Creek	37S	17W	7	1,680	122	102.00	PC, S, R, I	e	SCS
Spring Creek Reservoir	2B2-2g	Spring Creek	37S	17W	25,26	727	39	12.00	I		USGS
Undercurrent	2B2-2h	Shoal Creek	37S	17W	17			108.00			SCS
Lost Creek	2B2-2j	Lost Creek	38S	18W	4	256	20	6.4	FC, S	e	SCS
Cave Creek	2B2-2k	Cave Creek	38S	18W	10	150	17	2.6	PC, S	e	SCS

[a]Number is for map location snd identification only.

Major Purpose: P - Fishing; FC - Flood Control; I - Irrigstion; MI - Municipal and Industrial; P - Power; R - Recreation; S - Sediment; St - Stockwatering.

[c]Source of Information: CNI - Conservation Needs Inventory (unpublished report); SCS - Soil Conservation Service Work Unit or River Baain Staff; U - Utah State Engineer Biennial Reports; USGS - United States Geological Survey, Water Supply Paper 920.

[d]Values in parentheses () are estimated.

[e]Reconnaissance investigation and evaluation made by Soil Conservation Service during river basin study.

[f]Preliminary investigation msde by Soil Conservation Service during watershed planning.

LAND RESOURCES

Potential land resource development encompasses better utilization and conservation of existing resources, improved management, prevention of soil erosion, installation of facilities and application of proper land treatment measures. Potential development also includes watershed stabilization, harvesting and processing forest wood products, rangeland improvement, and cropland development.

WATERSHED STABILIZATION

Potential watershed stabilization includes measures to reduce erosion, sedimentation, and flood flows. Treatment measures include stabilization of critical areas, disturbed areas, and gullies and streams. Critical areas are those suitable for mechanical treatment such as contour trenching or furrowing, and vegetation improvement. Disturbed areas include roads, trails, mining dumps, and other such areas. Gully and stream stabilization includes measures such as drop structures, riprap, gully plugs, planting streambank vegetation, and other means. Watershed stabilization on National Forest and public domain (Table 42) could reduce erosion by 18 percent, sediment by 19 percent, and flood damages by 27 percent (Table 43). Although considerable range seeding, brush control, and other land treatment has been accomplished on private and state lands, no potential development was identified specifically for watershed stabilization.

TABLE 42.--Potential watershed stabilization, Beaver River Basin

Treatment	Unit	Amount
National Forests		
Critical area	Acres	45,670
Disturbed area	Acres	2,480
Gully & stream	Miles	269
Public Domain		
Critical area	Acres	28,820
Disturbed area	Acres	300
Gully & stream	Miles	35

TABLE 43 .--Potential annual reduction in erosion, sediment and flood damages, Beaver River Basin[a]

Damage	Unit	Amount
National Forests		
Erosion	Acre-feet	75
Sediment	Acre-feet	28
Flood	Dollars	23,300
Public Domain		
Erosion	Acre-feet	24
Sediment	Acre-feet	8
Flood	Dollars	1,400

[a]Associated with watershed stabilization potential shown in Table 42.

CROPLAND

The Beaver River Basin contains approximately 1,092,000 acres of arable land (map following page 112). In 1965, irrigated cropland comprises 115,200 acres of which 16,980 acres are idle and dry cropland comprises 80,390 acres of which 25,200 acres are idle. Roads, towns, farmsteads, reservoirs, and railroads comprise 32,130 acres. The remaining arable land of approximately 864,360 has potential as cropland. Development of these areas is dependent on availability of water. Some potential exists for dry cropland development, most of this area is better suited for irrigated cropland because of marginal precipitation. In addition, there are approximately 701,000 acres of salt and alkali-affected lands. Some of this land may be suitable for irrigation if reclaimed by installation of drains and leaching or other intensive treatment.

RANGELAND IMPROVEMENT

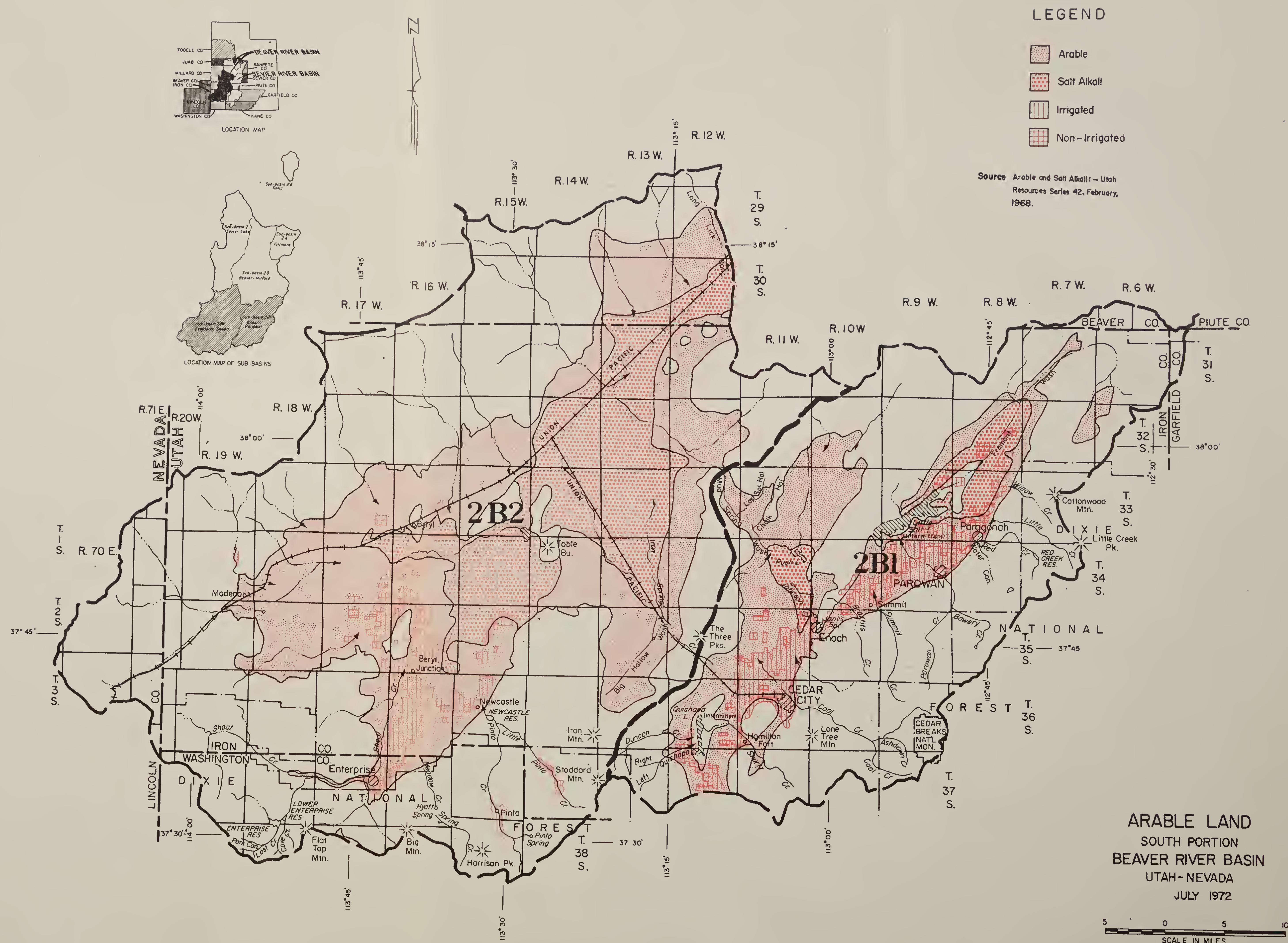
There are over 4 million acres of rangeland which is suitable for sustained livestock grazing. On much of this land, the grazing potential is realized, but large acreages of underdeveloped rangeland still exist. Potential developments were identified for forage improvement and range facilities. Forage improvement was considered for those areas where the installation of livestock facilities and the application of land treatment are necessary to increase forage production and utilization.

Potential range facilities and forage improvements on National Forests, state, and private lands are shown in Table 44. Potential developments on public domain were not evaluated. Potential increased grazing from forage improvement on private and state land is 31,470 animal unit months (AUM's). The increase was not evaluated on National Forest lands. Potential increased grazing from management associated with range facilities on private and state lands is estimated to be over 95,700 AUM's.

TABLE 44.--Potential range facility and forage improvement on National Forests, state, and private lands, Beaver River Basin

Improvement	Unit	Amount
National Forests		
Water developments	Number	206
Fences	Mile	245
Forage improvement	Acre	63,400
Private		
Water development	Number	5,790
Fences	Mile	1,735
Forage improvement	Acre	118,080
State		
Water development	Number	2,420
Fences	Mile	715
Forage improvement	Acre	23,690

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE



U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

FOREST WOOD PRODUCTS

The total basin resource includes about 110,400 acres growing 663 million board feet of sawtimber and 48,200 acres growing 22 million board feet of poles. There is potential to improve this resource through reforestation of 6,820 acres and to improve the quality of timber through thinning and pruning on 1,030 acres. Increased harvest of most species is limited because of conflicts with other forest uses. Aspen could be more fully utilized if demand increases.

The Basin's 1.3 million acres of pinyon-juniper stand contains an estimated 222 million cubic feet of wood fiber. Development of additional products from these trees, pruning, and other ways to utilize or improve this resource are present.

R E C R E A T I O N

The proximity of the Beaver River Basin to national parks and monuments, outstanding scenic and geologic vistas, significant historical and archeological sites, and major transportation facilities, combine to provide considerable potential for enhancement and development. There are sufficient resources available to potentially meet the projected recreation demand in nearly all activities. Potential recreational developments include big game and fish habitat improvement and outdoor recreational facilities.

BIG GAME AND FISH HABITAT IMPROVEMENT

Potential big game habitat improvement primarily for deer, includes browse planting and pinyon-juniper removal. There is a potential to improve 24,550 acres of deer habitat on National Forests and 18,000 acres on public domain. Competing uses for elk and antelope habitat generally limit identifying significant development for these game animals. Development potentials on private and state lands were not identified.

Potential fish habitat improvement on National Forests include 19 miles of streamflow stabilization, 28 miles of streambank protection, 14 miles of pool-riffle improvement, and 43 acres of reservoir stabilization.

OUTDOOR RECREATION FACILITIES

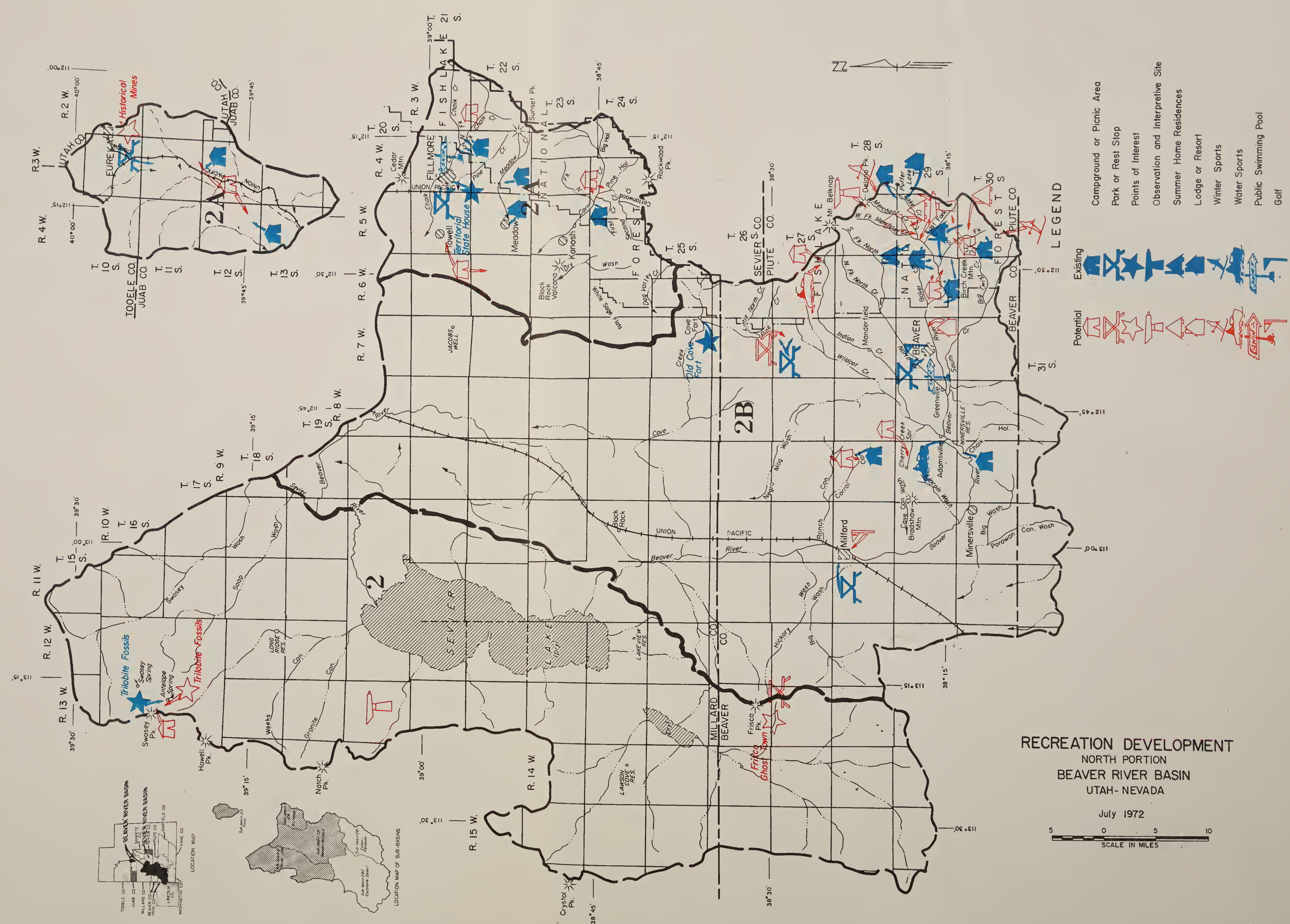
Potential outdoor recreation facilities include 36 campgrounds and picnic areas, 3 parks and rest stops, 7 points of interest, 5 observation and interpretive sites, 7 summer home residence sites, 2 lodge and resort sites, 2 winter sports sites, 2 water sports sites, 1 public swimming pool, and 2 golf courses. A partial listing of potential outdoor recreation facilities, irrespective of land ownership and administration, is shown on the map following page 114.

With the large expanse of National Forests and public domain available for recreation pursuits, private recreation opportunities are largely restricted to activities not provided on public lands. In 1968, the county technical action panels conducted an appraisal of development potentials for private outdoor recreation (Table 45).

TABLE 45.--Development potential by county[a] for private outdoor recreation facilities, Beaver River Basin, 1968

	Development potential				
Recreation Activity	Not evaluated	Zero	Low	Medium	High
Vacation cabins, etc.				BJM	I
Vacation camp sites				BIJM	
Pack trip sites	JM			I	B
Transient camp sites				IJ	B
Picnicking areas	J	B	I		
Cold water fishing			BIJM		
Golf courses	J		IB	M	
Small game & upland game bird hunting			BI	J	M
Big game hunting				BJ	IM
Natural, scenic, and historical areas				BJ	IM
Vacation farms and ranches	I			BJM	
Winter sports areas	J		M	I	B

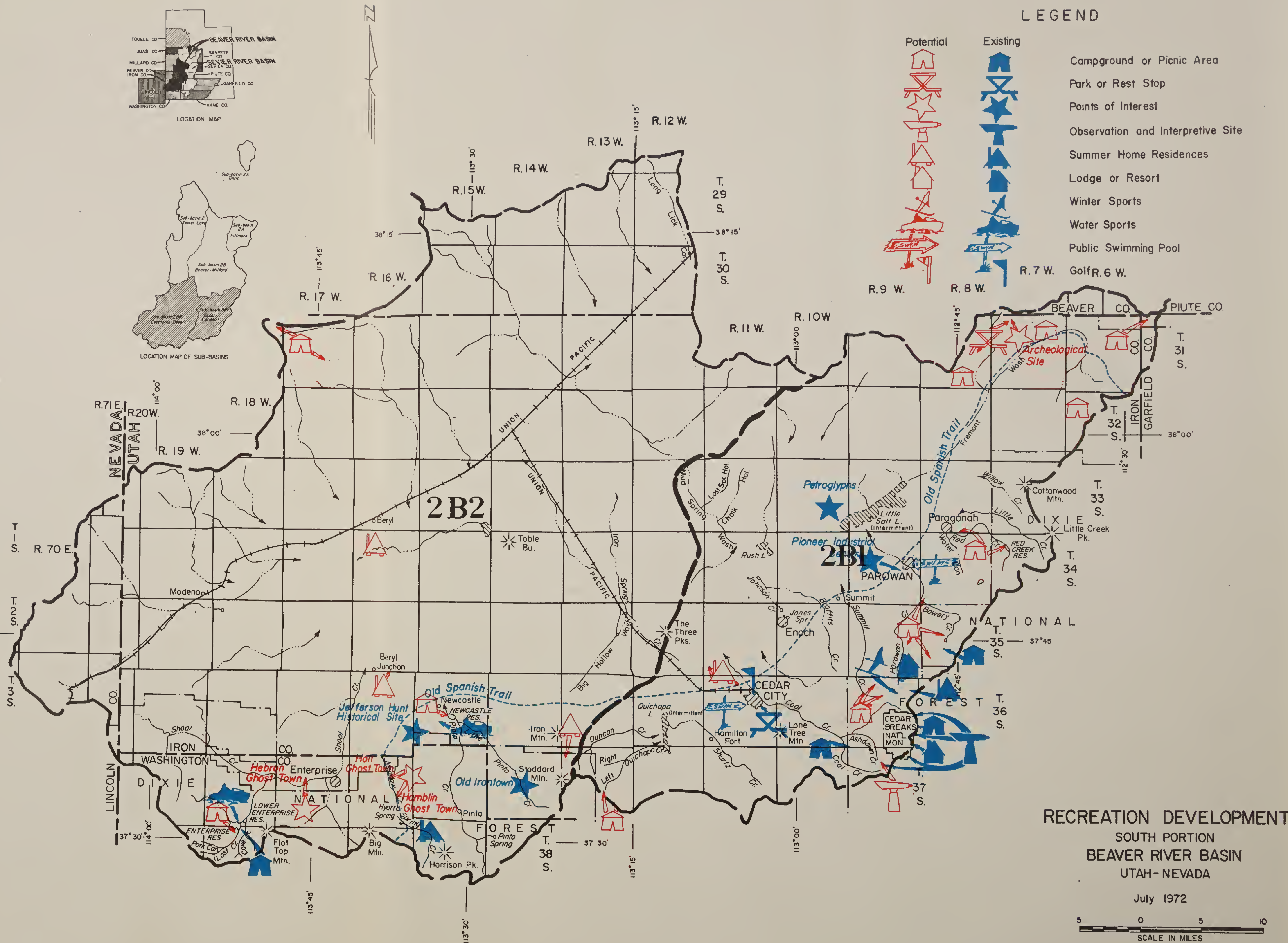
[a]Letters represent the following counties: B-Beaver; I-Iron; J-Juab; M-Millard



RECREATION DEVELOPMENT
NORTH PORTION
BEAVER RIVER BASIN
UTAH-NEVADA

July 1972

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE



RECREATION DEVELOPMENT

SOUTH PORTION

BEAVER RIVER BASIN

UTAH-NEVADA

July 1972

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

CHAPTER IX

OPPORTUNITIES FOR DEVELOPMENT

This chapter identifies the amount of the potential development discussed in Chapter VIII which could be implemented by U. S. Department of Agriculture programs and other related programs in the next 10 to 15 year period. Each existing USDA program is briefly described in Chapter VII. Benefits of these development opportunities will include increased economic returns and conservation of natural resources. Resource, economical, and environmental impacts are evaluated.

DEVELOPMENT OPPORTUNITIES

Development opportunities are presented under four major categories: watershed protection and flood prevention, water resources, land resources, and recreation development. These development opportunities are those which could be implemented in the next 10 to 15 year period and include either new development or acceleration of existing programs. These opportunities should not be interpreted as the only developments needed, or that they will be supported by public, state, and federal agencies. Legal and administrative constraints may prevent implementation of some opportunities in some areas.

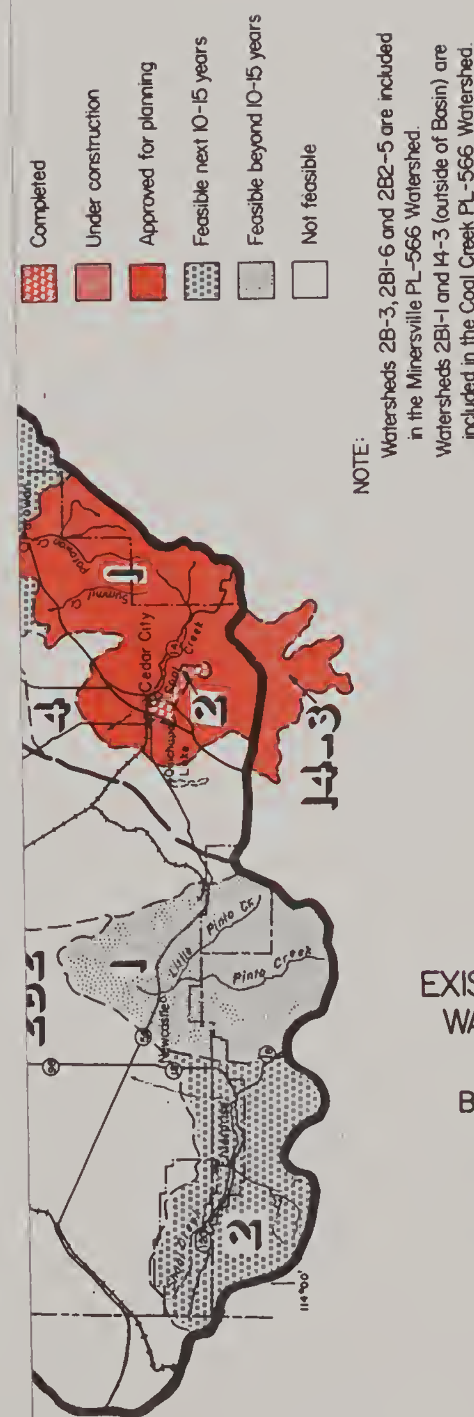
WATERSHED PROTECTION AND FLOOD PREVENTION (PL-566)

There are several opportunities in the Beaver River Basin for PL-566 projects. Project opportunities, feasibility, and planning status for all the watersheds in the Basin are shown in Table 46. Existing and potential watershed projects are shown on the map following page 116. Out of 22 watersheds, four show feasibility for construction within the next 10 to 15 years and three show feasibility beyond this period. The accelerated program opportunities that may be met in these feasible PL-566 watersheds include: (1) technical assistance for opportunities identified on private land; (2) cost sharing on 64 miles of canal lining, 8 reservoirs, and 10 recreation sites; and (3) loans to sponsoring organizations for their share of the costs.

TABLE 46.--PL-566 project opportunities, feasibility, and planning status for watersheds, Beaver River Basin

Watershed			Opportunity						
Number	Name	Size (acre)	On-farm land treatment	Conveyance system improvement	Reservoir development	Watershed stabilization	Range improvement	Recreation	Feasibility and planning status
2-1	Sevier Lake	1,145,270	No	No	No	No	No	Yes	Not feasible
2A-19	Tintic	162,370	No	No	No	No	No	No	Not feasible
2A-24	Chalk Creek	115,990[a]	Yes	Yes	Yes	Yes	Yes	Yes	Feasible within 10-15 years
2A-25	Corn Creek	213,200	Yes	Yes	Yes	Yes	Yes	Yes	Feasible within 10-15 years
2B-1	Beaver	210,080	Yes	Yes	Yes	Yes	Yes	Yes	Feasible beyond 10-15 years
2B-2	Wildcat Creek	112,980	Yes	Yes	Yes	Yes	Yes	Yes	Feasible beyond 10-15 years
2B-3	Minersville	249,000[b]	Yes	Yes	Yes	Yes	Yes	Yes	Approved for constr. 5/65
2B-4	Milford	122,830	No	No	No	No	No	Yes	Not feasible
2B-5	Cove Creek	49,740	No	Yes	No	No	Yes	No	Not feasible
2B-6	Black Rock	341,380	No	No	No	No	No	No	Not feasible
2B-7	Jacobs Lake	381,850	No	No	No	No	No	No	Not feasible
2B1-1	Coal Creek	245,000[c]	Yes	Yes	Yes	Yes	Yes	Yes	Authorized for planning
2B1-2	Green's Lake	6,240	-	-	-	-	-	-	Completed project 3/59
2B1-3	Red Creek	249,780	Yes	Yes	Yes	Yes	Yes	Yes	Feasible within 10-15 years
2B1-4	Quichapa Creek	102,130	Yes	No	No	No	No	No	Not feasible
2B1-5	Rush Lake	124,480	No	No	No	No	No	Yes	Not feasible
2B1-6	Other	11,000	-	-	-	-	-	-	Inc. w/Minersville WS
2B2-1	Pinto Creek	166,920	Yes	Yes	Yes	Yes	Yes	Yes	Feasible beyond 10-15 years
2B2-2	Shoal Creek	141,920	Yes	Yes	Yes	Yes	Yes	Yes	Feasible within 10-15 years
2B2-3	Beryl	635,200	Yes	No	No	No	No	No	Not feasbible
2B2-4	Big Hollow	503,850	No	No	No	No	No	No	Not feasible
2B2-5	Other	9,000	-	-	-	-	-	-	Inc. w/Minersville WS

a A portion of this watershed containing only Chalk Creek drainage (approximately 36,000 acres) was authorized for planning in January 1955 and terminated in August 1956 due to lack of support.
b Acreage includes watersheds 2B1-6 and 2B2-5
c Includes 47,550 acres in watershed 14-3 (outside of Basin)



EXISTING AND POTENTIAL WATERSHED PROJECTS (PL-566)

BEAVER RIVER BASIN

UTAH - NEVADA

SEPTEMBER 1972

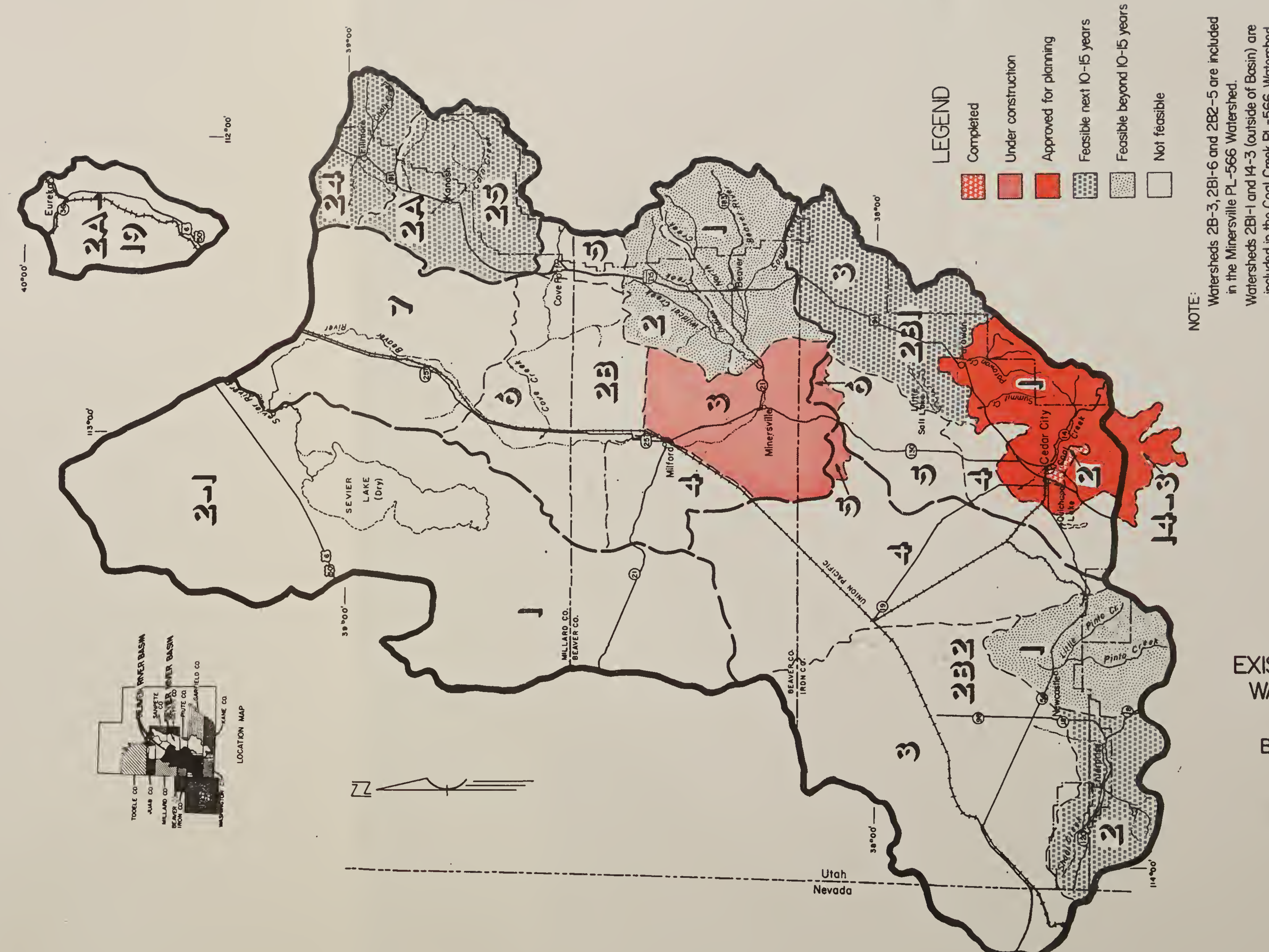
10 0 10

SCALE IN MILES

TABLE 46.--PL-566 project opportunities, feasibility, and planning status for watersheds, Beaver River Basin

Watershed			Opportunity						
Number	Name	Size (acre)	On-farm land treatment	Conveyance system improvement	Reservoir development	Watershed stabilization	Range improvement	Recreation	Feasibility and planning status
2-1	Sevier Lake	1,145,270	No	No	No	No	No	Yes	Not feasible
2A-19	Tintic	162,370	No	No	No	No	No	No	Not feasible
2A-24	Chalk Creek	115,990[a]	Yes	Yes	Yes	Yes	Yes	Yes	Feasible within 10-15 years
2A-25	Corn Creek	213,200	Yes	Yes	Yes	Yes	Yes	Yes	Feasible within 10-15 years
2B-1	Beaver	210,080	Yes	Yes	Yes	Yes	Yes	Yes	Feasible beyond 10-15 years
2B-2	Wildcat Creek	112,980	Yes	Yes	Yes	Yes	Yes	Yes	Feasible beyond 10-15 years
2B-3	Minersville	249,000[b]	Yes	Yes	Yes	Yes	Yes	Yes	Approved for constr. 5/65
2B-4	Milford	122,830	No	No	No	No	No	Yes	Not feasible
2B-5	Cove Creek	49,740	No	Yes	No	No	Yes	No	Not feasible
2B-6	Black Rock	341,380	No	No	No	No	No	No	Not feasible
2B-7	Jacobs Lake	381,850	No	No	No	No	No	No	Not feasible
2B1-1	Coal Creek	245,000[c]	Yes	Yes	Yes	Yes	Yes	Yes	Authorized for planning
2B1-2	Green's Lake	6,240	-	-	-	-	-	-	Completed project 3/59
2B1-3	Red Creek	249,780	Yes	Yes	Yes	Yes	Yes	Yes	Feasible within 10-15 years
2B1-4	Quichapa Creek	102,130	Yes	No	No	No	No	No	Not feasible
2B1-5	Rush Lake	124,480	No	No	No	No	No	Yes	Not feasible
2B1-6	Other	11,000	-	-	-	-	-	-	Inc. w/Minersville WS
2B2-1	Pinto Creek	166,920	Yes	Yes	Yes	Yes	Yes	Yes	Feasible beyond 10-15 years
2B2-2	Shoal Creek	141,920	Yes	Yes	Yes	Yes	Yes	Yes	Feasible within 10-15 years
2B2-3	Beryl	635,200	Yes	No	No	No	No	No	Not feasbible
2B2-4	Big Hollow	503,850	No	No	No	No	No	No	Not feasible
2B2-5	Other	9,000	-	-	-	-	-	-	Inc. w/Minersville WS

a A portion of this watershed containing only Chalk Creek drainage (approximately 36,000 acres) was authorized for planning in January 1955 and terminated in August 1956 due to lack of support.
b Acreage includes watersheds 2B1-6 and 2B2-5
c Includes 47,550 acres in watershed 14-3 (outside of Basin)



EXISTING AND POTENTIAL
WATERSHED PROJECTS
(PL-566)
BEAVER RIVER BASIN
UTAH - NEVADA
SEPTEMBER 1972

10 0 10
SCALE IN MILES

Prevention of floodwater and sediment damage, reduction in water shortages and fluctuations, and providing new recreational facilities are the primary elements of feasible PL-566 projects. There are also several factors which could change the feasibility of these projects. These include: (1) importation of water, (2) changes in the content or interpretation of present water rights, (3) a change in PL-566 policy to allow more flexibility in agricultural water management portions of a project, (4) conflicts between alternative resource uses, and (5) environmental impacts. A brief discussion of the watershed area, problems, and improvement measures for the seven feasibile watershed projects follows.

CHALK CREEK WATERSHED (2A-24)

Chalk Creek Watershed is located in Millard and Sevier Counties and contains 115,990 acres of which 2,820 acres are in Sevier County. Approximately 34 percent of the watershed is in the Fishlake National Forest, 56 percent is in private ownership, 7 percent is public domain, and 3 percent is state land. The population of the watershed in 1960 was estimated to be 1,882 of which 85 percent was in the town of Fillmore. Elevations range from 4,600 to 10,200 feet. Annual precipitation varies from 13 to 30 inches.

Primary problems are irrigation water shortages and floodwater and sediment damages. Annual on-site erosion damage is estimated at $8,900, and sediment damage at $9,400. Annual floodwater damages are projected to be $5,200 on National Forests and $7,600 on private and community property. The average annual root-zone consumptive use deficit is 12,390 acre-feet. Conveyance and on-farm irrigation efficiencies are low, no large regulating or storage reservoirs exist, and seasonal supplies do not coincide with crop demands. Flat-water recreation is not available in the immediate area. About 20 miles of stream channels are rapidly eroding.

The features include one reservoir (2A-24a) to provide storage of 3,000 acre-feet for irrigation water, 2,000 acre-feet for municipal water, 1,344 acre-feet for sediment and floodwater, and 1,100 acre-feet and 70 surface acres for recreation; 13 miles of canal lining; and two campground or picnic developments. These measures are estimated to cost over $4 million.

CORN CREEK WATERSHED (2A-25)

Corn Creek Watershed contains 213,200 acres of which 212,600 acres are in Millard County and 600 acres in Sevier County. Approximately 48 percent of the watershed is in the Fishlake National Forest, 34 percent is in private ownership, 13 percent is public domain, 4 percent is state land, and 1 percent is Indian Trust lands. The 1960

population was 765 of which 32 percent was in Meadow and 52 percent in Kanosh. Elevations range from 4,800 to 10,200 feet. Annual precipitation varies from 13 to 30 inches.

There is an average annual root-zone consumptive use deficit of 10,750 acre-feet. On-farm irrigation efficiencies are low throughout the watershed, and conveyance efficiencies are low in the Kanosh area. Large regulating or storage reservoirs do not exist and seasonal water supplies do not coincide with the crop demands. Minor flood damage has occurred in the Kanosh area and the average annual damage is estimated to be $980. Flat-water recreation is not available in the immediate area. More than 61 miles of stream channel are evaluated as rapidly eroding.

Features include one reservoir (2A-25c) to provide storage of 2,200 acre-feet for irrigation, 334 acre-feet for flood prevention, and 1,500 acre-feet and 62 surface acres for recreation; 4 miles of canal lining, and one campground. These measures are estimated to cost over $1 million.

BEAVER WATERSHED (2B-1)

There are 210,080 acres in the Beaver Watershed of which 204,450 acres are in Beaver County and 5,630 acres in Iron County. Land ownership and administration is divided between National Forests 45 percent, public domain 32 percent, private 17 percent, and state 6 percent. The 1960 population in the watershed was 1,980 of which 78 percent was in Beaver City. Elevations range from 5,500 to over 12,000 feet. Average annual precipitation varies from 10 to 40 inches. This watershed has many miles of perennial streams and montane scenery. Highway I-15 traverses the area in a north-south direction.

Average annual on-site erosion damage is estimated to be $24,280. Over 43 percent of the perennial streams are estimated to be moderately to rapidly eroding. The average annual flood damage is estimated to be $4,420, while the average annual sediment damage is estimated to be $5,610. Average annual root-zone consumptive use deficits is 2,170 acre-feet. On-farm and conveyance irrigation efficiencies are low. A high water table exists on approximately 4,900 acres.

Features include two reservoirs (2B-1g and 2B-1k) to provide storage of 250 acre-feet for irrigation, 910 acre-feet for flood prevention, and 2,850 acre-feet and 102 surface acres for recreation; 47 miles of canal lining, 4,900 acres of drainage, and 4 recreation campgrounds. It is estimated that these features will cost over $6.7 million.

WILDCAT CREEK WATERSHED (2B-2)

This watershed encompasses 112,980 acres, within Beaver County. Approximately 20 percent of this watershed is in the Fishlake National Forest, 61 percent is public domain, 14 percent is privately owned, and 5 percent is state land. Manderfield is the only community and has a 1970 population of 25. Elevations range from 5,700 feet to over 12,000 feet. Precipitation varies from 14 to 40 inches, with an average watershed precipitation of 15 inches. Highway I-15 traverses the watershed in a north-south direction. The average annual consumptive use deficit is 740 acre-feet for about 1,500 acres of irrigated lands. On-farm irrigation and conveyance efficiencies are low. Approximately 82 percent of the watershed has a high to moderately high erosion rate. Sediment damage is estimated at $5,850 annually.

The major feature is a reservoir (2B-2a) to provide storage of 300 acre-feet for irrigation, 200 acre-feet for sediment and flood control, and 500 acre-feet and 23 surface acres for recreation at an estimated installation cost of $645,000.

RED CREEK WATERSHED (2B1-3)

Red Creek Watershed contains 249,780 acres of which 236,500 acres are in Iron County and the remainder are in Beaver and Garfield Counties. Approximately 51 percent is public domain, 29 percent private land, 4 percent state land, and 16 percent is in the Dixie National Forest. Paragonah is the only town in the watershed and has a population of 300. Elevations range from 5,500 feet to 10,000 feet. Valley areas receive 8 to 12 inches of precipitation annually and up to 30 inches is received in the high mountain areas.

Problems include irrigation water shortages, channel erosion, and sediment damages. Nine miles of stream channel are rapidly eroding. Annual sediment damages are estimated to be $2,760. About 40 percent of the area is characterized by moderately high sheet erosion. On-farm irrigation efficiencies are low. In the Little Creek area, conveyance efficiencies are low, there are no storage or regulating reservoirs, and seasonal supplies do not match crop demands. There is an overall average annual consumptive use deficit of approximately 2,400 acre-feet.

Features include one reservoir (2B1-3a) to provide storage of 340 acre-feet for irrigation, 300 acre-feet for floodwater and sediment, and 460 acre-feet and 43 surface acres for recreation; and one campground. Estimated installation cost is $510,000.

PINTO CREEK WATERSHED (2B2-1)

This watershed contains 166,920 acres of which 59 percent is in Iron County and 41 percent in Washington County. About 51 percent of the watershed is in the Dixie National Forest, 26 percent is private land, 19 percent is public domain, and 4 percent is state land. The watershed population in 1960 was 175. About 100 of the residents live in the community of New Castle. Elevations range from 5,200 to 9,100 feet. Average annual precipitation varies from 9.5 to 22 inches.

Problems include an average annual root-zone consumptive use deficit of 2,510 acre-feet, and low on-farm irrigation efficiencies. Average annual sediment damage is estimated at $3,480. About 39 percent of the watershed has an erosion classification of moderately to extremely high. Eight miles of stream channels are evaluated as rapidly eroding.

Major features include a reservoir (2B2-1h) to provide storage of 220 acre-feet for sediment and floodwater, and 840 acre-feet and 54 surface acres for recreation; and one campground. Installation costs for these features is estimated to be $400,000.

SHOAL CREEK WATERSHED (2B2-2)

Shoal Creek Watershed contains 141,920 acres divided between Iron County, 46,260 acres; Washington County, 93,480 acres; and Lincoln County, Nevada, 2,180 acres. Seventy-seven percent is in the Dixie National Forest, 14 percent is private land, 8 percent is public domain, and 1 percent is state land. Total watershed population in 1960 was 945, of which 91 percent was in the town of Enterprise. Elevations range from 5,300 to 7,300 feet and average annual precipitation varies from 10 to 16 inches.

Primary problems are irrigation water shortages and floodwater and sediment damage. Annual sediment damages are estimated at $10,790. Average annual flood damages are projected to be $2,200 for summer floods and $9,300 for winter floods. The average annual root-zone consumptive use deficit is 2,950 acre-feet. On-farm irrigation efficiencies are low. Irrigation water supply availability does not coincide with crop demands.

Features include a reservoir (2B2-2f) to provide storage of 500 acre-feet for irrigation, 780 acre-feet for sediment and floodwater, and 400 acre-feet and 50 surface acres for recreation; and one campground. These project measures are estimated to cost over $1.2 million.

WATER RESOURCES

In addition to PL-566 projects, other USDA programs and closely related programs of other agencies can assist in implementing development opportunities. Some USDA programs include Rural Environmental Assistance, Conservation Operations, Resource Conservation and Development, and Farmers Home Administration. Opportunities for water resource development depend upon increased utilization of the present supply. This will generally result in a decrease of recharge to ground-water reservoirs which will aggravate the declining water levels. Data are not available to adequately analyze and evaluate this effect and further consideration should be given to the results of water resource developments prior to implementation. Opportunities for development are discussed for irrigation improvement and reservoir development.

IRRIGATION IMPROVEMENTS

Irrigation improvements include on-farm land treatment and off-farm conveyance system improvements. These irrigation improvements are projected to provide an increase in overall irrigation efficiency of 6 percent by 1980 with accelerated programs. This increase in overall irrigation efficiency is projected to reduce the average annual root-zone consumptive use deficit by 7,780 acre-feet.

Accelerated on-farm land treatment measures include lining 128 miles of ditches and installing over 8,000 acres of sprinkler systems or land leveling.

Off-farm conveyance system improvements include canal lining, pipelines, and related structures. No attempt was made to separately identify and evaluate diversions, measuring devices, turnouts, wasteways and other similar structures that are part of conveyance and distribution systems. Development opportunities include 92 miles of canal lining and pipelines.

Irrigation structures contribute to efficient use of water.

Land leveling is essential to efficient irrigation in many areas of the Basin.

RESERVOIR DEVELOPMENT

Opportunities for reservoir development include 13 sites (Table 47) which could provide 25,250 acre-feet of storage. Benefits could include additional late season irrigation water, additional flat-water recreational opportunities, reduced sediment yields and flood flows, and municipal water. Nine of the reservoirs could provide a total of 7,310 acre-feet of irrigation water storage. Eleven could provide approximately 600 surface acres for recreation with a projected capacity of 46,100 visitor-days. In addition, 3,700 acre-feet of storage could be included for sediment, 2,590 acre-feet for temporary flood flow detention, and 2,000 acre-feet for municipal use. Site locations are shown on the map following page 108.

LAND RESOURCES

Development opportunities for land resources include watershed stabilization and rangeland improvement. Proper land management must be correlated with these improvement opportunities to protect initial investments and to achieve benefits into the future. Numerous USDA programs can assist in achieving development opportunities. These include National Forest development and Multiple Use programs, Resource Conservation Programs of Soil Conservation Service, and other related programs.

WATERSHED STABILIZATION

Watershed stabilization measures on National Forest land are included in the tabulation below. Opportunities on public domain, state, and private lands were not evaluated.

Treatment measure	Amount
Critical area stabilization	12,720 Acres
Disturbed area stabilization	1,631 Acres
Gully & stream stabilization	47 Miles

Watershed stabilization will prevent erosion of 36 acre-feet annually, sediment deposition of 14 acre-feet, and flood damages of $5,700.

TABLE 47.--Development opportunities for reservoirs (10-15 years), Beaver River Basin

Project	Class of Structure	Drainage area	Height of dam	Volume of fill	Surf. Area Recreation Pool	Capacity Total[b]
	a	sq. mi.	feet	cu. yd.	acre	ac. ft.
2A-24a Chalk Cr. Upper	c	58.0	136	1,788,500	70	7,444
2A-25c Big Hollow	b	2.2	81	251,500	62	4,034
2A-25d Cottonwood	c	12.2	105	535,400	57	2,365
2B-1g Lower Three Cr.	c	37.8	105	607,900	81	3,220
2B-1k North Creek	c	14.1	87	260,000	21	790
2B-2b Indian Creek[c]	c	19.9	83	450,500	30	1,100
2B-2a Milk Ranch[c]	c	8.8	84	91,600	23	800
2B1-3a Little Creek	b	11.8	71	116,100	43	1,100
2B2-1c Holt Canyon	b	31.7	54	221,900	66	1,250
2B2-1h Upper Pinto	b	10.3	64	78,600	54	1,060
2B2-2f Indian Rock	c	102.0	57	201,800	97	1,680
2B2-2j Lost Creek	b	6.4	45	71,300	-	256
2B2-2k Cave Creek	b	2.6	26	11,700	-	150

a Class (a) Structure located in rural or agricultural areas where failure may damage farm buildings, agricultural land, or township and country roads.

(b) Structure located in predominantly rural or agricultural areas where failure may damage isolated homes, main highways or minor railroads or cause interruption of use or service or relatively important public utilities.

(c) Structure located where failure may cause loss of life, serious damage to homes, industrial and commercial buildings, important public utilities, main highways or railroads.

b Includes temporary floodwater storage

c Milk Ranch and Indian Creek are alternate sites for irrigation water storage.

Drop structures (above) and gully plugs (below) are effective means of stabilizing streams and gullies.

Contour trenches help stabilize a critical area at the head of Meadow Creek in the Fillmore subbasin.

Aerial seeding is often used to revegetate areas disturbed by large wild fires.

RANGELAND IMPROVEMENT

Development opportunities include measures to improve forage and provide range facilities. Forage improvement was considered on areas of rangeland where soil and climatic conditions are most suitable for treatment. Installation of livestock facilities were evaluated in conjunction with forage improvement to more fully utilize the grazing resource. Forage improvement includes such treatment as brush control, seeding, plowing, and chaining; livestock facilities include water developments (troughs, wells, pipelines, and spring developments), and fences (Table 48). Development opportunities were not evaluated on public domain.

TABLE 48.--Development opportunities for range facilities and forage improvement on National Forests, state, and private lands, Beaver River Basin

Treatment and/or facility	Unit	Amount
National Forests		
Water developments	No.	154
Fences	Miles	65
Forage improvement	Acres	15,086
Private		
Water developments	No.	778
Fences	Miles	310
Forage improvement	Acres	24,100
State		
Water developments	No.	631
Fences	Miles	188
Forage improvement	Acres	7,790

Accelerated forage improvement programs could provide increased livestock grazing of 2,240 AUM's on National Forests, 8,800 AUM's on private lands, and 2,110 AUM's on state lands or a total 13,450 AUM's. Range facilities on private and state rangelands could provide 18,150 AUM's in addition to those provided through forage improvement. Improved management would permit additional grazing production beyond that shown.

Plowing (above) and chaining (below) are effective ways of removing undesirable vegetation, improving soil moisture conditions, and establishing better forage.

Juniper areas with no protective understory are highly erodable and produce little forage.

Range improvement permits the establishment of desirable forage species such as crested wheatgrass.

RECREATION DEVELOPMENT

Development opportunities for recreation include improvement of big game habitat and installation of outdoor recreational facilities. The big game habitat improvement includes browse planting and pinyon-juniper control for deer. Development opportunities to improve deer habitat through accelerated programs include 8,000 acres on National Forests and 18,000 acres on public domain. Big game habitat improvement on National Forests and public domain is projected to provide an estimate increase of 16,470 hunter days for the accelerated program.

Facilities on National Forests include seven campgrounds and on public domain, facilities include two picnic areas, one point of interest, one interpretive site, and five campgrounds. Approximate site locations are shown on the map following page 114. These facilities could provide a recreation capacity of 117,000 visitor-days.

I M P A C T S

Environmental and economic impacts are described by individual development opportunities. Environment impacts are described in general terms since detailed on-site investigations were not conducted. Detailed environmental investigations will be required prior to implementation of development opportunities. Total installation costs of all development opportunities are estimated to be over 25 million dollars, with annual costs of $1,737,600 and annual benefits of $1,805,800.

IRRIGATION IMPROVEMENTS

More efficient use of irrigation water could result in the following environmental effects: (1) reduced tail water from irrigated areas which now provide a portion of the annual consumptive use of surrounding native vegetation, (2) increased acreage of cultivated lands and extension of the growth period into the fall, thus enhancing the pastoral setting, and (3) decreased recharge to ground water, thus reducing artesian pressure of wells and possibly contributing to a decrease in ground-water quality in some areas. Canal lining and pipelines could reduce the growth of riparian vegetation.

Off-farm lining installation costs for the accelerated program are estimated to be $2,423,100 or $177,040 annually; and benefits are $169,420 annually for a 1:1 benefit-cost ratio. On-farm land treatment installation costs are estimated to be $2,931,800 or $198,500 annually; and benefits are $316,680 annually for a benefit-cost ratio of 1.6:1.

Environmental effects related to the 13 reservoirs include impacts on 1,214 acres required for construction. Additional reservoir fish and wildlife habitat could be provided while reducing stream fish and game habitat. Stream turbidity, peak flood flows, erosion, and sediment yield could be reduced. Stream erosion may increase below the Wide Hollow reservoir. Approximately 174 acres would be inundated and then exposed annually by fluctuating reservoir levels. Flat-water scenery could replace free-flowing willow lined streams. Road relocation may cause minor inconvenience to traffic during construction and may have an impact on existing streams, fish and wildlife habitat, and esthetic values. Noise, dust, and smoke during construction would have a minor temporary effect since it is several miles to most towns and recreational areas. Increased impacts from additional recreational use should be provided for, and questions related to responsibility for installation and administration of facilities should be resolved. Further studies regarding recreation impacts on watershed resources should be initiated prior to construction of reservoirs. The Forest Service does not support Wide Hollow reservoir as a development alternative due to adverse environmental impacts.

The 13 selected reservoirs are estimated to cost $15,534,700 or $995,130 annually; and annual benefits are $765,930 with a benefit cost ratio of 0.8:1.

Fluctuating reservoir water-levels provide extremes in scenic views from full (above) to nearly empty (next page).

Fluctuating reservoir water-levels provide extremes in scenic views from full (preceding page) to nearly empty (above).

WATERSHED STABILIZATION

Construction will cause temporary environmental disturbances. Some wildlife habitat will be improved while habitat for other species will be reduced. Water quality and stream habitat for fish will be improved from reduced sediment. Total installation cost is estimated to be $1,050,200; annual costs $60,680; annual benefits $57,030; and the benefit-cost ratio, 0.9:1.

RANGELAND IMPROVEMENT

The environmental effects of range improvement programs are generally favorable. Wildlife habitat could be changed in many cases. Vegetation composition could change and grass forage could increase. Fences and watering facilities may change wildlife use patterns and have an impact on populations. Erosion and sedimentation could be reduced. Landscape scenes could be changed in some areas.

Estimated installation costs and a comparison of annual benefits and costs for accelerated programs are given in Table 49 for forage improvement and for range facilities.

TABLE 49.--Comparison of annual benefits and costs for forage improvement and range facilities, Beaver River Basin

Land Class	Installation costs	Annual Costs	Annual Benefits	B/C Ratio
	----------------Dollars	----------		
National Forest	224,340	17,900	15,040	0.8:1
Private	1,208,200	91,300	136,150	1.5:1
State	602,630	42,010	58,870	1.4:1

RECREATION DEVELOPMENT

Environmental impacts of big game habitat improvement could include an increase in wildlife population, reduced erosion, change in the pinyon-juniper ecology to more open brushland, and modified landscapes. Total installation costs for the accelerated program are estimated at $508,900, annual costs, $41,120; annual benefits, $83,700; and the benefit-cost ratio at 2.0:1.

Environmental impacts that could come from the installation of outdoor recreational facilities include a change in land use, an increase in noise and dust, and increase in services for sewage and solid waste disposal, greater disturbance of wildlife, and changes in the natural landscape. The estimated installation cost is $563,600; annual costs, $113,900; annual benefits, $203,000; and an overall benefit-cost ratio of 1.8:1.

CHAPTER X

OTHER PROGRAMS FOR FURTHER DEVELOPMENT

Other programs and measures beyond the scope of this report should be considered for resource development. Many technological advances and improved management techniques are currently under study and should be considered in future planning.

ALTERNATIVE APPROACHES

Alternative ways to meet the needs and develop the resources include alternative resource development, weather modification, water importation, water yield improvement, and water supply management. More efficient management of water resources through improved regulatory storage and more extensive flow measurement and forecasting networks could extend present limited supplies.

RESOURCE POTENTIAL FOR ALTERNATIVE DEVELOPMENT

A comparison was made of the total available water resource and total water uses in water budget areas for the 1956-1965 period. The average annual available water supply during this ten year period was 584,000 acre-feet and uses were 598,000 acre-feet. In addition, total ground water outflow was 128,000 acre-feet. The ground water outflow and water budget area consumptive use exceeded the available supply by 360,000 acre-feet.

The effects of increasing the efficiency of use and total water use can only be answered by showing the results of that action on other uses. If goals to increase the utility of water are to be realized, future consequences of these actions need to be studied. A change in the present water use pattern or in a specific use of water will have one or more of the following effects: (1) change consumptive water use rates; (2) change the time, place and availability of occurrence; (3) change quality; (4) affect land use; or (5) change the overall environment.

Water use efficiencies from the diversion to the root-zone (Chapter IV) vary by subbasins from 28 to 36 percent. Such efficiencies can be misleading when considered in a large hydrologic system of which the individual farm is merely a part. In practice, the available water resource is often used and reused several times resulting in a water use efficiency considerably higher. On irrigated cropland, when the total available water resource is compared to consumptive use, the water use efficiency in the Beaver River Basin is 71 percent.

The present water use efficiencies by subbasins are as follows: Fillmore, 68 percent; Beaver, 78 percent; Cedar, 44 percent; and Escalante, 126 percent. When all other water uses were included with irrigated cropland consumptive use in the water budget areas, the water use efficiency within the Beaver River Basin was 102 percent. Water use efficiencies by subbasin are then as follows: Fillmore, 99 percent; Beaver, 102 percent; Cedar, 99 percent; and Escalante, 112 percent.

There is a direct relationship between the consumptive use of water and agricultural crop income. In general terms, as water use increases, net crop income also increases.

ALTERNATIVES

There are several alternative ways of increasing the water available for consumptive use on irrigated croplands. This can be accomplished by the following means:

(1) Increase surface water conveyance efficiency from the point of diversion to the farm headgate.

(2) Increase on-farm irrigation efficiencies.

(3) Storage of excess seasonal surface water.

(4) Increase irrigated cropland acreage.

(5) Increase pumping of groundwater.

(6) Change in irrigated land cropping patterns.

(7) Combinations of the above practices.

Going and accelerated programs are a combination of development alternatives 1 and 2 listed above. With these programs, consumptive use of water on irrigated cropland would increase from an average annual rate of 190,000 acre-feet during the base period to 223,000 acre-feet in 1980 and 234,000 acre-feet during the projected 2020 period. This would result in the efficiency of consumptive use on irrigated cropland compared to available water resource increasing from 71 percent in 1965 to 83 percent in 1980 and 87 percent in 2020. When other water uses are considered, the percentage would increase from 102 percent in 1965 to 108 percent in 1980 and 110 percent in 2020 (Table 50).

Program alternatives could have a direct affect on the groundwater resources. The average annual ground water decline during the base period was 36,000 acre-feet. With the programs, this rate will be increased to 68,700 acre-feet in 1980 and 80,200 acre-feet by 2020 (Table 51) assuming that the increased consumptive use will have a 100 percent direct effect on the ground water.

With alternative 3, the volume of surface water available for irrigation does not have the same pattern during different periods of the year as crop consumptive use needs. This results in excess supply of irrigation water during the winter and spring months and deficits during the summer and fall months. Timing and distribution of excess water can be changed to help meet water deficits during other months by providing reservoir storage. As water conveyance and application efficiencies increase, the quantity of water excess to crop needs increases. The quantity of surface water at the point of diversion that is excess to present and projected needs are as follows: 1965, 58,000 acre-feet; 1980, 65,000 acre-feet; and 2020, 107,000 acre-feet. This water could be stored and released during times of water deficits to increase consumptive use on irrigated croplands.

TABLE 50.--Comparison of present and projected total water use and available water resource, Beaver River Basin

Subbasin	Available Water Resource	Water Use 1965	Water Use 1980	Water Use 2020	Comparison of Use To Available Resource 1965	1980	2020
	------1,000 Acre-Feet------				------Percent------		
Fillmore	168	167	176	179	99	105	107
Beaver-Milford	134	137	147	148	102	109	110
Cedar-Parowan	185	184	192	195	99	103	105
Escalante Desert	97	109	115	119	112	119	123
Basin Total	584	598	631	642	102	108	110

TABLE 51.--Present and projected[a] ground-water decline, Beaver River Basin

Subbasin	Ground-water Decline 1965	1980	2020
	--------------Acre-Feet------------		
Fillmore	11,110	19,860	22,950
Beaver-Milford	4,460	14,590	15,580
Cedar-Parowan	7,080	14,700	18,420
Escalante Desert	13,350	19,600	23,300
Basin Total	36,000	68,750	80,250

a Assuming consumptive use increase has 100 percent direct effect on ground water.

Under the present land and water use pattern, there is 1.92 acre-feet of soil moisture consumed by crops for each acre of irrigated land. This comes from precipitation (.88 acre-foot) and irrigation water (1.04 acre-foot).

If the same land and water use relationships are assumed in the future as exists now, as irrigation water conveyance and application efficiencies increase, the irrigated acreage could also be increased (alternative 4). At the rate of 1.04 acre-feet per acre, projected increases in water use efficiencies could provide 40,390 acre-feet of water to irrigate an additional 38,830 acres by 1980. By 2020, this would provide 84,670 acre-feet to irrigate 84,410 acres of new land if the irrigated acreage is allowed to vary year to year with the available irrigation water supply. The additional precipitation on these lands would be 34,000 acre-feet by 1980 and 72,000 acre-feet by 2020.

Ground-water pumping (alternative 5) has become a vital and interconnected part of irrigation practices. During the 1956-1965 base period,.56 percent of the irrigation water was pumped from ground water and 44 percent came from surface sources. Increased ground-water pumping could be considered as an alternative means of overcoming present consumptive use deficits. Ground water is generally available throughout the irrigated areas and would be available for irrigation.

A coordinated plan that recognizes the interconnection between surface and ground water can be developed to assure a more efficient and sustained agricultural economy. Surface water could be used during periods of high flows and ground water used only as needed. The ground water could then be pumped during periods when surface flows are low to meet crop needs. This type of a plan would need to limit the irrigated acreage to assure future availability of ground water.

Alternative cropping patterns (alternative 6) researched by Giles, Utah State University, determined the impacts of the court decree of a water supply of 4 acre-feet per acre. Generally this research concluded that under these conditions and low irrigation efficiencies (30%), farm income would be maximized when the cropping pattern included 50 percent potatoes, 22 percent wheat and 28 percent idle land. When irrigation efficiencies were increased to the medium range (50%), the optimum combination of crops was 50 percent potatoes, 25 percent wheat and 25 percent alfalfa. With high irrigation efficiencies (70%), the cropping pattern remained the same, but excess water was available to irrigate additional land. It can be concluded from this research that lands that are presently idle within irrigated farms will come into production as irrigation conveyance efficiencies increase over time.

WEATHER MODIFICATION

Weather modification techniques are becoming increasingly sophisticated. An increase in precipitation of 5 - 15 percent has been predicted in some areas using present methods. This could produce approximately 20,000 acre-feet of runoff to the irrigated areas. The effects of weather modification on other areas and upon biota ecosystems has not been evaluated but is under study. Legal questions relating to ownership of atmospheric water have not been resolved.

WATER IMPORTATION

Water importation will be necessary to meet future demands for municipal and industrial water in the Cedar City area and for supplemental irrigation water supplies in most cropland areas. It is anticipated that importation for municipal and industrial uses at Cedar City would come from headwaters of the Sevier River or from the Kolob Plateau area of the Virgin River drainage. Diversion of either of these sources would be costly, prohibiting use for agricultural purposes.

Diversion of additional irrigation water into the Basin is most logical through the existing Central Utah Canal into the Fillmore subbasin. This importation would come from the Colorado River drainage through facilities constructed in connection with the Central Utah Project.

WATER YIELD IMPROVEMENT

Manipulations of vegetation is an alternative method of improving the quantity and timing of upper watershed water yields. In some cases, the precipitation could be better utilized on-site rather than yielded for downstream use. Research to date has been on limited areas and for relatively short periods of time. Current indications are that for some assurance of success, vegetative manipulation should be carried out in areas where precipitation is in excess of 15 inches annually and is in excess of soil storage capacity. Conversion of aspen stands to grass may be one of the more promising opportunities.

WATER SUPPLY MANAGEMENT

Implementation of new or improved management methods can extend the use of the limited water resources. These include water storage, flow measurements, and weather and water supply forecasting.

Over two-thirds of the water supply is discharged by most streams in a three month period each spring. The need for surface storage to better utilize the water supply has already been emphasized in this report. There is additional storage potential in ground-water reservoirs through artificial recharge during wet years. More adequate technology is needed to facilitate optimum use of ground-water reservoirs. This would include not only recharge technology, but the extent and other physical properties necessary for management of these potentials.

As competing uses increase the value of water, adequate measurement of stream flows becomes mandatory for proper management. Installation of additional monitoring stations could provide more data in areas where present management is inadequate. Replacement of mechanical equipment with electronic devices could increase the reliability and utility of data. Water quality monitoring is becoming more important. Unmanned stations could record sediment and solute concentrations at critical points. Technological developments are needed to measure ground-water movement and monitor ground-water quality. There is also a need for more complete measurement of ground-water withdrawals.

Development of the satellite program has been a boon to weather and water supply forecasting. Further development and use of related techniques will allow better utilization and management of water supplies. Installation of a complete telemetry network in the Basin would permit almost instantaneous collection of data from single storms as well as collection of data on a regular basis. This would permit better management of storage facilities to control flood flows and prevent downstream damage.

JOINT PLANNING WITH OTHER AGENCIES

All planning for development of the water and related resources should be coordinated and in most cases, jointly planned with the other agencies concerned. The South-Central and Southwestern Planning District organizations, both covering parts of the Basin, should coordinate their activities with others to effect more efficient planning. These organizations could be instrumental in formulation of an information program so that everyone concerned will have a common understanding of the water and related land resource problems. Often, the relationship of present water supply and management practices are not adequately understood. As a result, some conservation practices and projects have been applied in a piecemeal and local manner instead of through a coordinated approach.

A better understanding of land managing agency programs is needed. People often resist some conservation programs not realizing that reaping short-term benefits can impair or destroy resources far into the future.